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WADC TECHNICAL REPORT 52-70

EVALUATION OF INSTALLATION OF UHF TAIL CAP ANTENNA IN F-94A AIRCRAFT

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COMPONENTS AND SYSTEMS LABORATORY

MARCH 1952

WRIGHT AIR DEVELOPMENT CENTER

[redacted]

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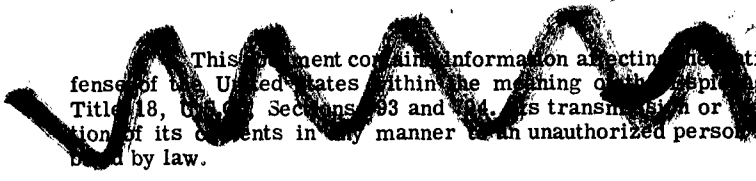

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WADC TECHNICAL REPORT 52-70 [redacted]N

EVALUATION OF INSTALLATION OF UHF TAIL CAP ANTENNA IN F-94A AIRCRAFT

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Robert C. Lollar, 2nd Lt, USAF

Components and Systems Laboratory

March 1952

SEO No. S-102-54

Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

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FOREWORD

The material presented in this report was authorized by Air Materiel Command Technical Instruction No. 2207-26A. Work was initiated as a project of the Wright Air Development Center and was completed under Service Engineering Order S-102-54, "Retrofit Installation of Radio Set AN/ARC-27 in USAF Aircraft." The project was administered by Components and Systems Laboratory of Weapons Components Division under the direction of Major William F. Sandusky, project engineer. Lieutenant R.C. Lollar served as assistant project engineer. Flight tests were conducted at Wright-Patterson Air Force Base during the priod from November 1951 to February 1952.

Included among those who cooperated in the tests were Lieutenant A.B. Crouch of Air Defense Command, and Messrs. R.T. Downey, C.W. Guelzow, E.L. Barton, W.E. Luginbuhl of Components and Systems Laboratory. Acknowledgement is also made of the technical assistance provided by personnel of Communication and Navigation Laboratory, WADC.

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ABSTRACT

An Ultra High Frequency Tail Cap Antenna, which was fabricated from Lockheed Aircraft Corporation drawings, was flush mounted on the tip of the vertical stabilizer of an F-94A aircraft and was subjected to flight tests as outlined in Military Specification MIL-A-6224. The antenna was tested on various UHF frequencies for range, audio quality, and signal strength, both air-to-air and air-to-ground.

The tests revealed that although some areas of low signal strength were found forward of the nose of the aircraft, the antenna provided satisfactory communications, both air-to-air and air-to-ground. Communications were audible to a maximum range of 240 miles. The radio-frequency input signal strength to the antenna was greater than the three-microvolt minimum at all elevation angles which were greater than 1.2 degrees.

The security classification of the title of this report is UNCLASSIFIED.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDING GENERAL:

for W. H. Congdon, Col. USAF
GORDON A. BLAKE
Brigadier General, USAF
Chief, Weapons Components Division

[redacted]

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS (Cont'd)

ILLUSTRATIONS (Cont'd)

ILLUSTRATIONS (Cont'd)

INTRODUCTION

Although a number of flight tests have been conducted in the past on experimental installations of ultra high frequency antennas, the tests included herein are the first to be conducted by the United States Air Force on a standard flush-mounted ultra high frequency antenna. Preliminary tests conducted by civilian contractors showed the tail cap antenna to have poor distribution in the forward hemisphere, particularly in the region below -5° of elevation.

To further investigate these phenomena, a standard Lockheed aircraft ultra high frequency (LAC UHF) tail cap antenna was installed on an F-94A aircraft, and flight tests were conducted at Wright-Patterson Air Force Base during the period from November 1951 to February 1952. It is believed that the data obtained from these tests will be of material assistance to other interested agencies engaged in ultra high frequency communications research and development. The data will be of particular value to agencies engaged in research and development in the field of antenna design and installation.

INSTALLATIONS

Installation of Equipment In Airplane.

The ultra high frequency tail cap antenna was fabricated and flush-mounted in the fin tip of an F-94A airplane (Figs. 1 and 2) in accordance with LAC Drawing No. 451838 entitled, "Vertical Stabilizer Antenna."

The Radio Receiver R-77A/ARC-3 and Radio Transmitter T-67/ARC-3, which are located in the radio compartment in the nose section in proximity to station 93 (Figs. 3 and 4), were removed and Radio Receiver-Transmitter RT-178/ARC-27 was installed as shown in figures 5 and 6. The Radio Receiver-Transmitter RT-178/ARC-27 unit was connected to the tail cap antenna by two lengths of coaxial cable in the following way: an 8-foot length of Radio Frequency Cable RG-8/U was used from the receiver-transmitter to the engine compartment; and a 20-foot length of Radio Frequency Cable RG-87A/U was used from the engine compartment to the tail cap antenna. Type "N" coaxial fittings were used to make the connections between the receiver-transmitter unit and the tail cap antenna.

The Radio Set Control C-628/ARC-27 was mounted in the radio panel, on the right-hand side of the cockpit, in space provided by the removal of Control Box C-118/ARC-3 (Figs. 7 and 8).

(Results of measurements of voltage standing wave ratio at representative frequencies are indicated in the Appendix to this report.)

FIGURE 1

ANTENNA INSTALLED IN F-94A

1. UHF Tail Cap Antenna With Fairing Installed

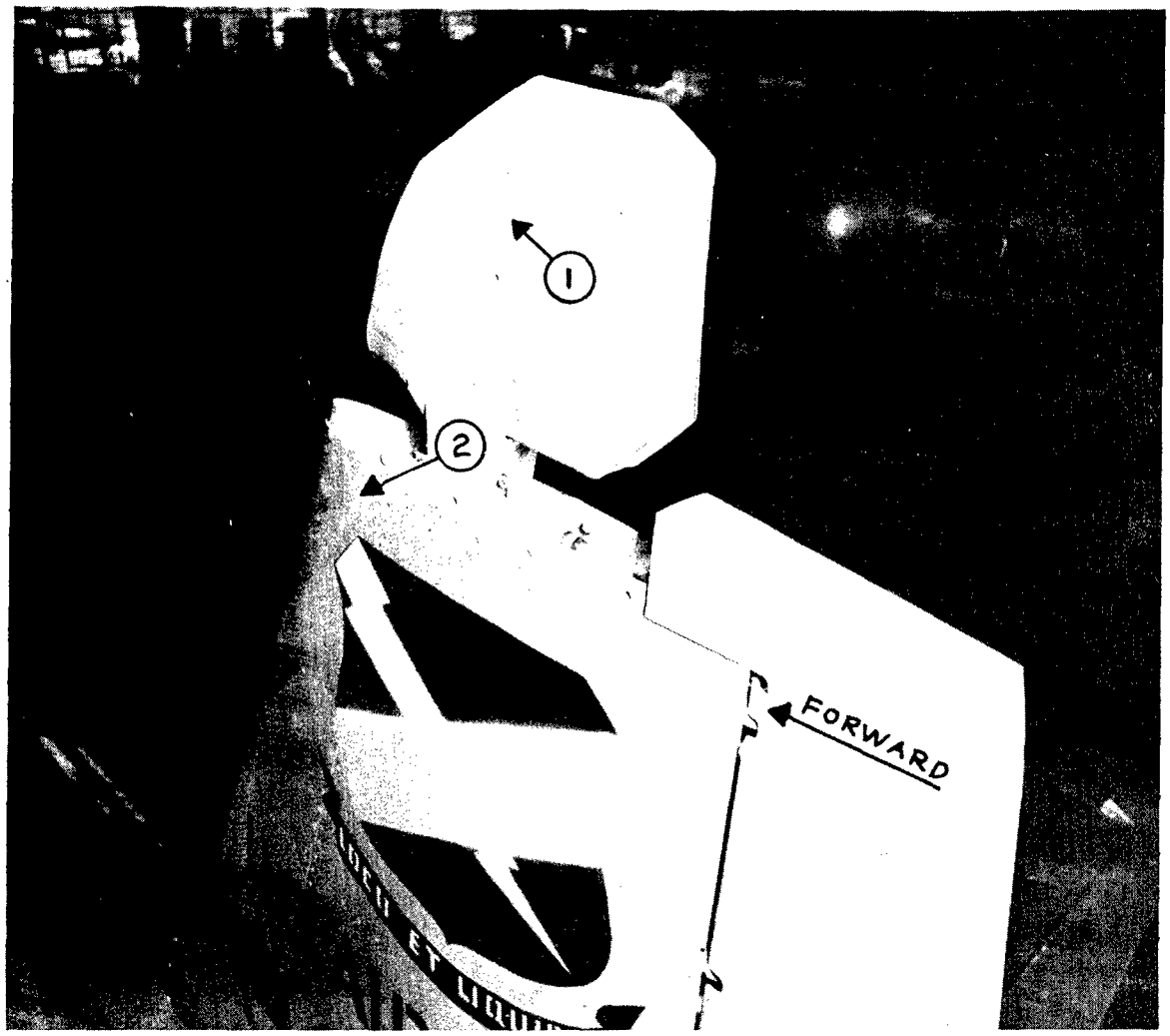

FIGURE 2

ANTENNA WITH FAIRING REMOVED

1. Lockheed UHF Tail Cap Antenna
2. Vertical Stabilizer of Aircraft

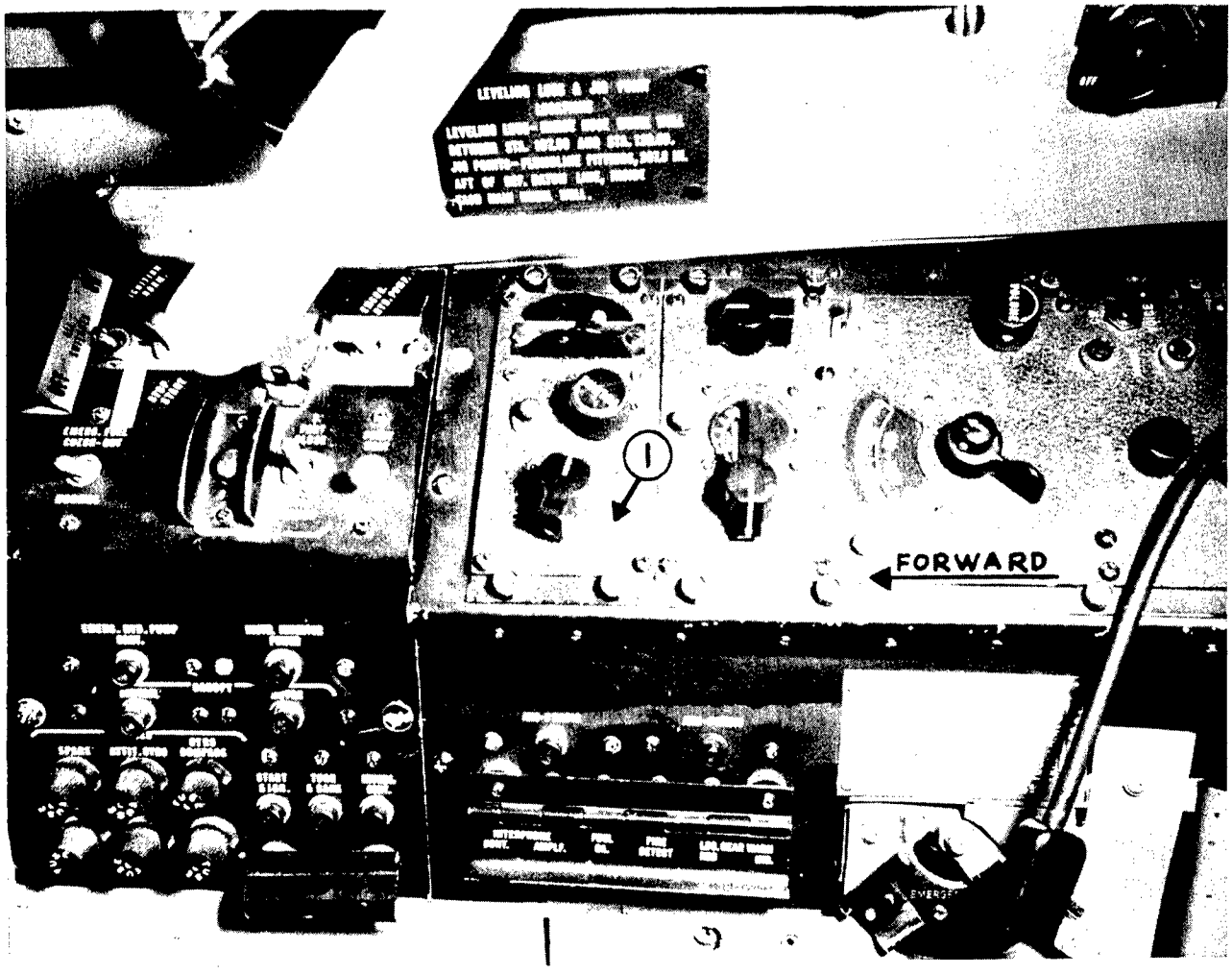

FIGURE 3

GENERAL VIEW OF RIGHT SIDE OF COCKPIT
WITH RADIO SET AN/ARC-3( ) INSTALLED

1. Control Box C-118/ARC-3

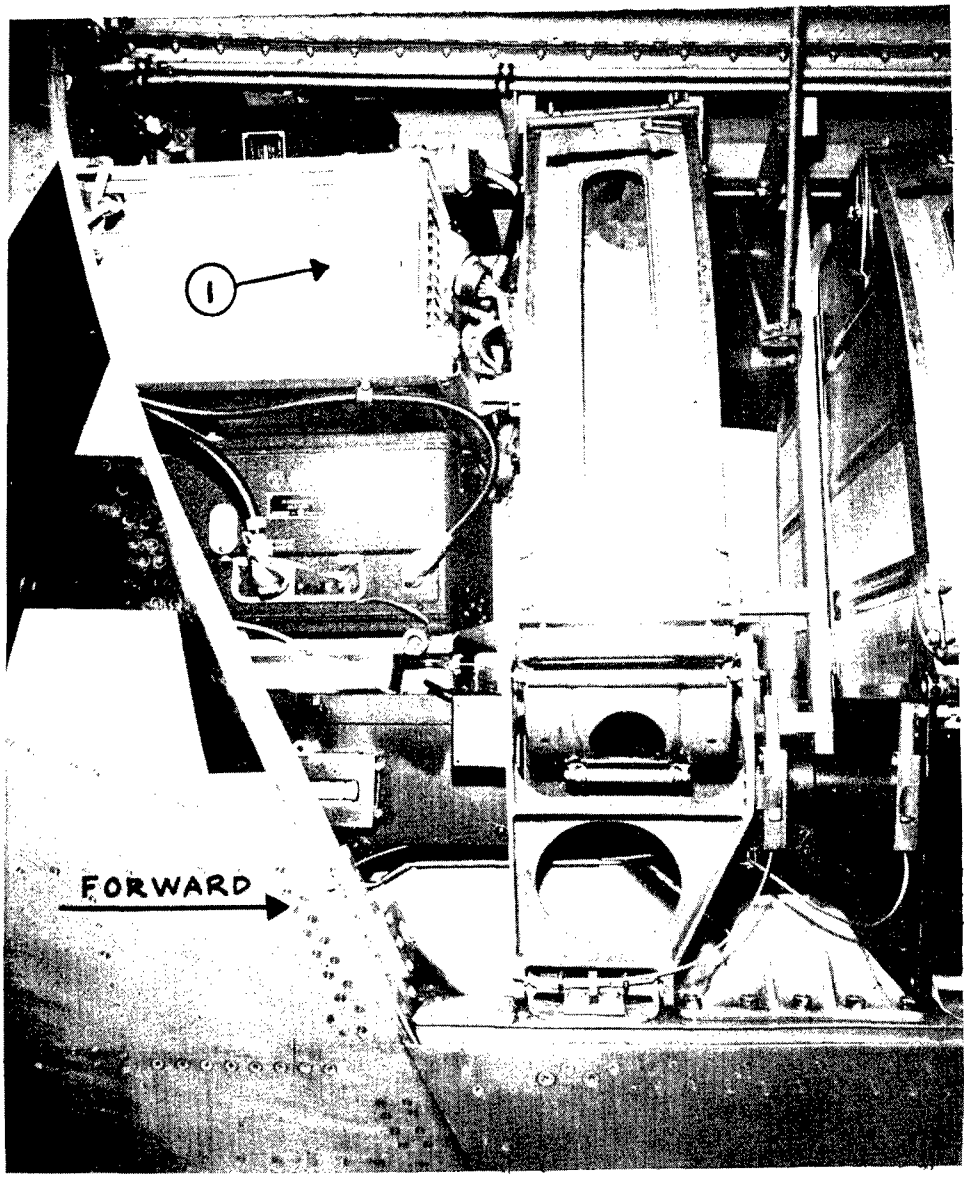

FIGURE 4

RIGHT SIDE OF RADIO COMPARTMENT
SHOWING RADIO SET AN/ARC-3 () INSTALLED

1. Radio Transmitter T-67/ARC-3

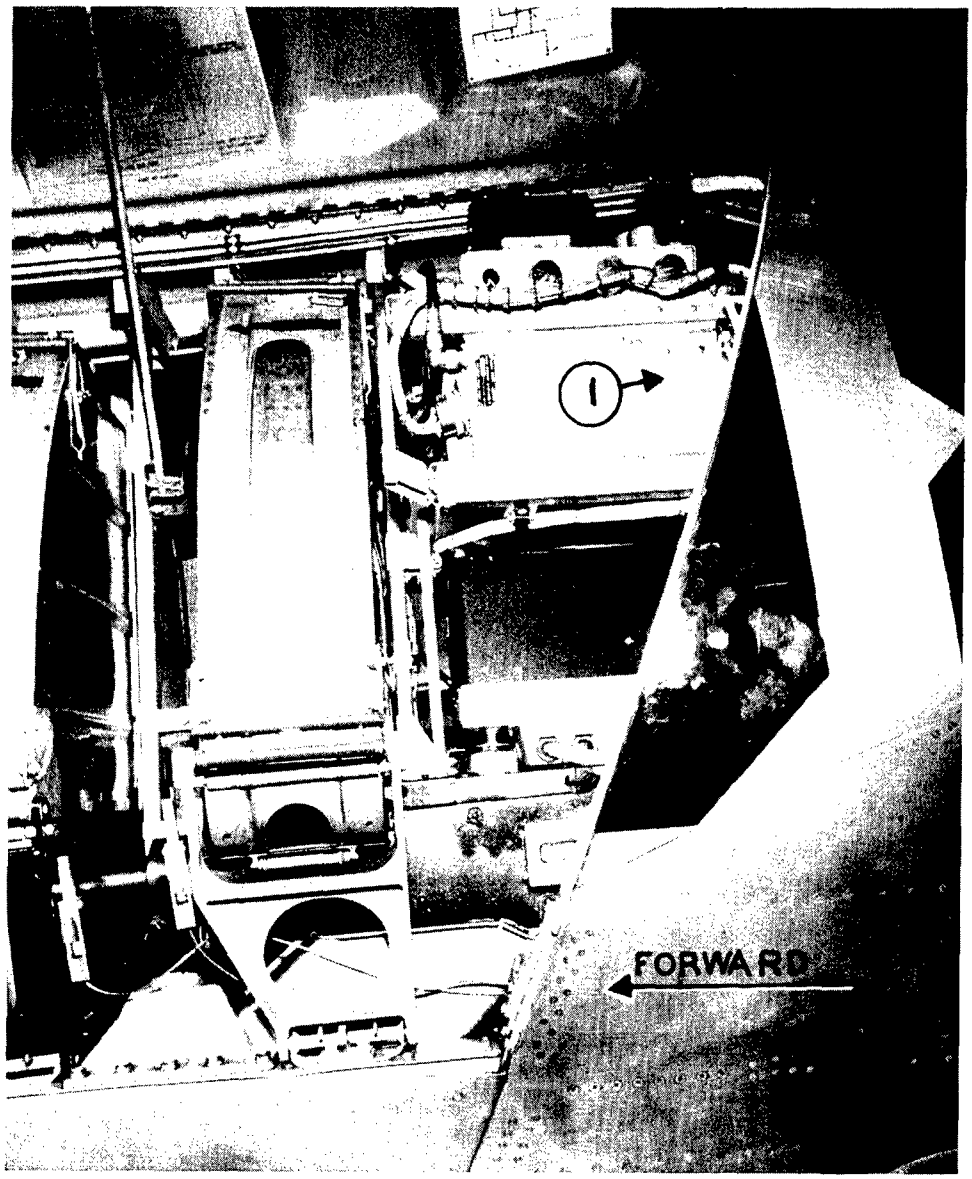

FIGURE 5

LEFT SIDE OF RADIO COMPARTMENT
SHOWING RADIO SET AN/ARC-3( ) INSTALLED

1. Radio Receiver R-77A/ARC-3

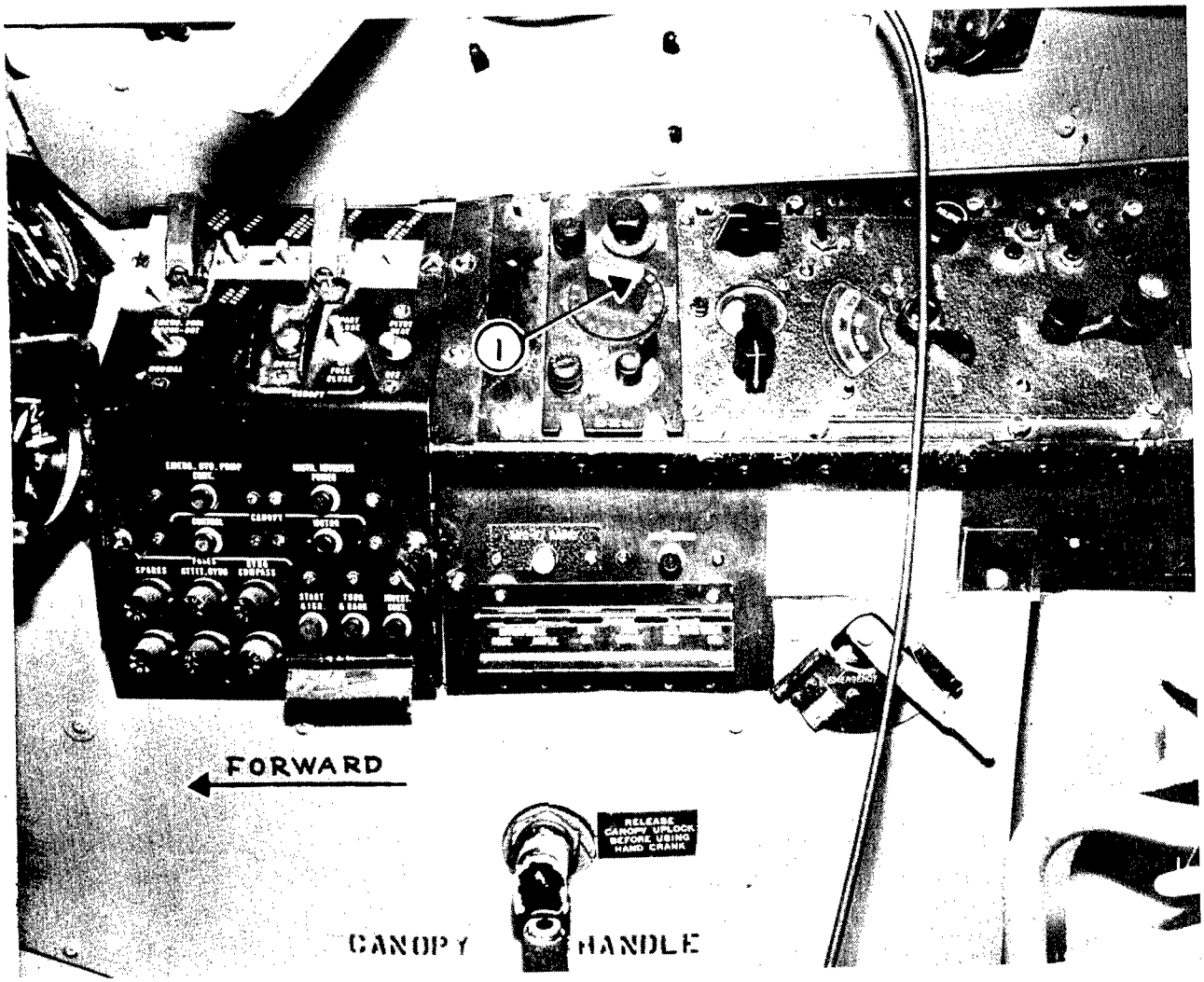

FIGURE 6

GENERAL VIEW OF RIGHT SIDE OF COCKPIT
SHOWING RADIO SET AN/ARC-27 INSTALLED

1. Radio Set Control C-628/ARC-27

FIGURE 7

RIGHT SIDE OF RADIO COMPARTMENT SHOWING
RADIO SET AN/ARC-27 INSTALLED

1. Transmitter of Radio Receiver-Transmitter RT-178/ARC-27, Right Side
2. Station 93

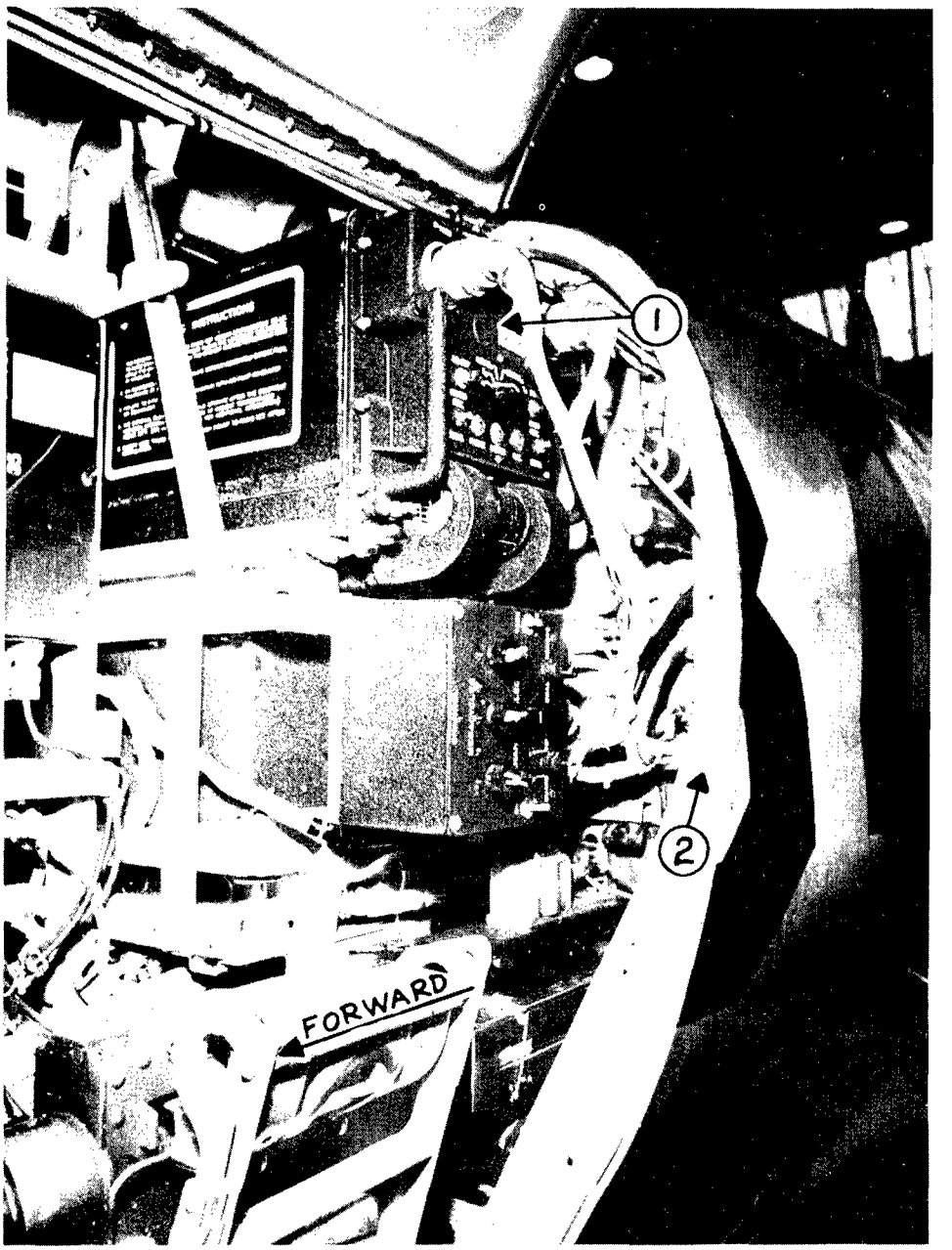

FIGURE 8
LEFT SIDE OF RADIO COMPARTMENT
SHOWING RADIO SET AN/ARC-27 INSTALLED

1. Transmitter of Radio Receiver-Transmitter RT-178/ARC-27, Left Side

2. Station 93

Installation of Ground Station Equipment.

Ground station equipment Radio Set AN/GRC-27 consisted of one Radio Transmitter T-217/GR( ) having an indicated power output of 100-125 watts, and one Radio Receiver R-278/GR( ) having a sensitivity of 1 1/2 to 2 1/2 microvolts. The antenna which was used was Antenna AS-505/GR( ), commonly called, "Squirrel Cage UHF Antenna." The antenna was mounted 70 feet above the ground and connected to the AN/GRC-27 ground installation by an 80-foot Radio Frequency Cable RG-17A.

The radio frequency signal intensities were measured across the automatic volume control to the ground of the Radio Receiver R-278/GR by means of a vacuum tube voltmeter. This voltage was then reduced to receiver input voltage by a calibrated signal source (Signal Generator Hewlett-Packard Model 608A) to produce the same automatic volume control to ground voltage. The relation

$$\frac{Ein}{Eout} = K$$

was used to obtain the conversion factor by which signal intensities, across the automatic volume control to ground, were reduced to receiver input intensity.

BENCH, PREFLIGHT, AND FLIGHT TESTS

Bench and Preflight Tests.

The Radio Set AN/ARC-27 was bench- and preflight-tested in accordance with the provisions of USAF Specification X-7305 entitled, "Bench and Preflight and Flight Test of Radio Set AN/ARC-27," dated 1 November 1951. Radio Set AN/ARC-27 was found to meet all bench- and preflight-test requirements.

Flight Tests.

1. General:

The evaluation of the ultra high frequency tail cap antenna was based upon flight test configurations as outlined in MIL Specification MIL-A-6229 entitled, "Antenna for UHF Airborne Communications Equipment, General Specification for Design of." The only deviations from the specifications were to permit even more exhaustive and comprehensive tests than those required by the specification. The three assigned frequencies tested were 229.2, 316.2, and 385.6 megacycles. The flight configurations which were flown during these tests included: clover-leaf pattern; 36-sided skid turn pattern; maximum range; straight-line pattern; and air-to-air test.

2. Clover-leaf Pattern:

The clover-leaf flight test pattern is illustrated in figure 9. This pattern was flown in both 30-degree and 45-degree intervals in a direction due south of the Ground Station AF5XX located at Wright-Patterson Air Force Base, Dayton, Ohio. The patterns were flown at predetermined altitudes and distances from the ground station. These altitudes and distances were so predetermined that the elevation angle (θ), between the reference ground plane of the ground station and the aircraft, would be the testing angle (θ = ARC TAN $\frac{h}{d}$). The 33.6-, 10.75-, and 3.62-degree angles were tested.

Continuous voice-communication was maintained between pilot and ground station on each predetermined azimuth heading of the aircraft. Receiver input voltage and azimuth heading were then recorded by the ground station operator and later were plotted on polar coordinates. The plot points on any radial of the polar plot will indicate the azimuth heading of the aircraft in reference to the ground station and the amplitude of the radio frequency signal when the aircraft was on that particular radial. Individual flight-test data and polar plots of the antenna radiation pattern, for each of the assigned frequencies and elevation angles which were tested, are shown in figures 10 through 17 and figures 18 through 21.

The overall results of these tests were satisfactory. Good two-way communication was maintained on all headings of the clover-leaf patterns. Inspection of the polar plots will show that, in general, there was an area of low signal strength forward of the aircraft. However, in view of the fact that this signal strength never fell below three microvolts, which is the minimum allowable signal strength for Radio Set AN/GRC-27 when it is used as an operational ground station, the antenna was considered to be acceptable.

3. Skid Turn Pattern, 36-sided:

The 36-sided skid turn flight pattern is illustrated in figure 22. This pattern was flown in intervals of 10 degrees. Continuous air-ground communication was maintained on all straight and level headings. Altitudes and distances from the station were predetermined so as to give a range of elevation angles (θ) between 1 and 12.75 degrees. Data was recorded and plotted on polar coordinates in the same manner as that used for the clover-leaf pattern. Individual flight test data and plots are shown in figures 23 through 40.

These tests were generally satisfactory. Good air-ground communication was maintained throughout with the exception of those test flights which were flown at an elevation angle (θ) of 1.1 degrees. When test flights were flown at an elevation angle (θ) of 1.1 degrees, the sensitivity fell below the minimum of three microvolts. However, air-ground communication, though not good, was adequate to give and receive instructions.

4. Maximum Range:

Maximum range tests were performed by flying due south from the ground station and reporting at 30-second intervals until the airborne transmission was no longer audible. These tests were performed at various altitudes between 5,000 and 35,000 feet, both for tail and nose headings of the aircraft to the ground station. The results of these flight tests are shown in figure 41.

Although no maximum range is specified for the Radio Set AN/ARC-27 by military specifications, the ranges from 100 miles at 10,000 feet altitude to 240 miles at 35,000 feet altitude were sufficient to make the ultra high frequency tail cap antenna acceptable for this portion of the flight tests.

5. Straight-line Pattern:

The straight-line pattern (Fig. 42) was flown on a heading of 180 degrees and 0 degrees, to and from the station, in order to determine the adequacy of communication coverage beneath the nose, beneath the tail, and directly behind the aircraft. Continuous air-ground communication was maintained throughout these test flights. The ground station recorded audio on tape recordings and plotted antenna input signal strength on rectangular coordinates. Individual flight test data and plots are shown in figures 43 through 46.

At all times during this portion of the tests, antenna input signal strength was higher than the three-microvolt minimum. Audibility was good throughout all phases with the exception of some garbling when the aircraft was directly over the ground station. This garbling was of approximately 15-seconds duration and, although not desirable, was not considered sufficient to justify the rejection of the antenna. The antenna was considered satisfactory for this portion of the flight test phase.

6. Air-To-Air Test:

The air-to-air test is shown in figure 47. An F-89C aircraft which was equipped with Radio Set AN/ARC-27 and an ultra high frequency tail cap antenna was used for this test as the airborne station. Individual flight test data is shown in figures 48 and 49. Continuous two-way communication was maintained between the two aircraft and was monitored and recorded by the ground station.

On those flights in which the F-94A aircraft was at the lower altitude, communication between the two aircraft was readable at all times; however, when the F-94A aircraft was at the higher altitude, there were short periods (not more than 1 minute) in which neither transmission nor reception was readable. This was particularly evident when the F-94A assumed a nose bearing to the other aircraft at ranges not exceeding 30 miles. Since these periods of nonreadability were of such short duration, the antenna was considered satisfactory.

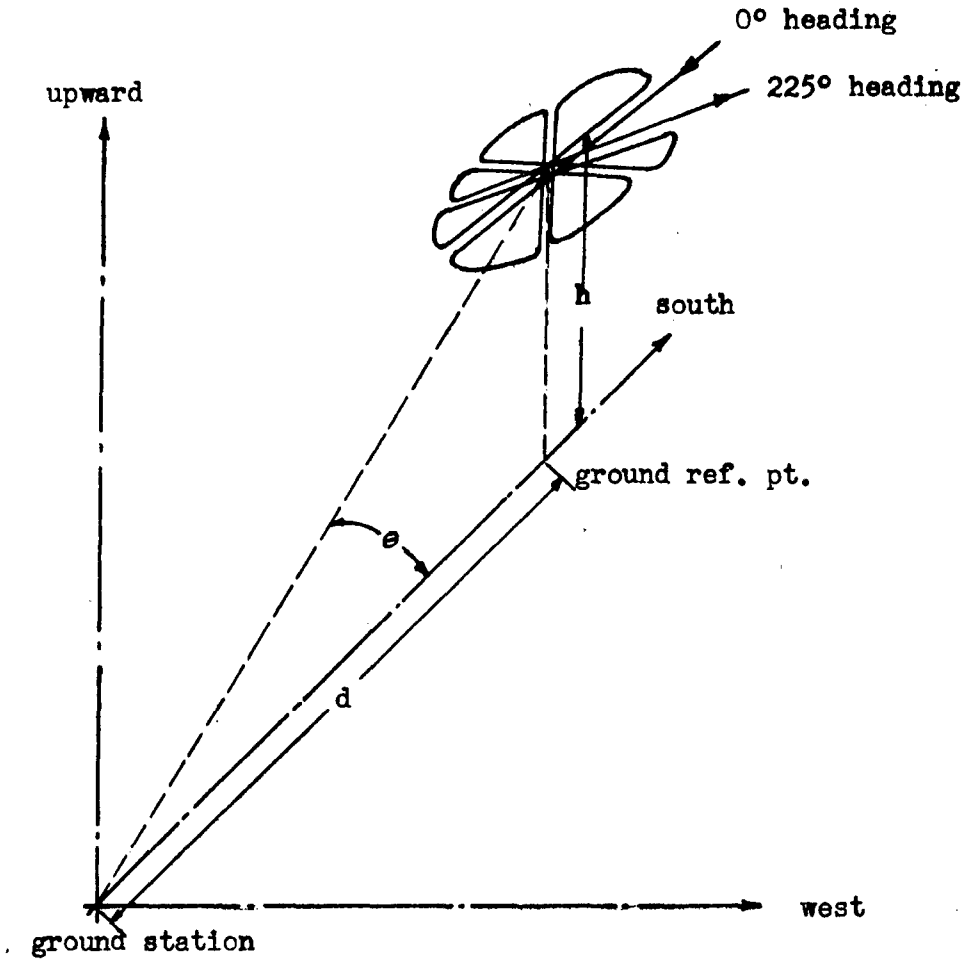

FIGURE 9

CLOVER-LEAF FLIGHT PATTERN

Key

h--Altitude of flight pattern
d--Distance of reference point from ground station
θ--Arc tan $\frac{h}{d}$ altitude of aircraft with respect to ground station

Patterns were flown at the following attitudes (θ)
θ=33.6° θ=10.9° θ=3.62°

Typical flight pattern showing relative positions of aircraft and ground station while an 8-sided (45-degree) clover-leaf pattern is being flown. Twelve-sided (30-degree) clover-leaf patterns were also flown during these tests. During these flights, the ground station, AF5XX, questioned and the pilot answered (two-way) on all tracks over the center of the clover-leaf.

AIRPLANE TYPE & NO.	FLIGHT NO.	REPORT SERIAL NO.	DATE	TIME
F-94A-2584	1	1	16 Jan. 1952	TAKE-OFF 1000
LOCATION – ☒ LOCAL ☐ CROSS-COUNTRY			MAX. ALTITUDE 35,000	LANDING 1155
WEATHER VFR				TOTAL FLIGHT 1+55
PROJECT Tail Cap Antenna Evaluation, UHF			E. O. NO. S-102-54	TOTAL ON EQUIP. 1+55
				PILOT Lt. A. B. Crouch
				CO-PILOT
				OBSERVERS

FOR USE ONLY ON REMOTELY-CONTROLLED AIRCRAFT

TYPE OF PROPELLER	ENGINE TYPE & NO.	RADIO	SERVO

	Variable	Steady				CAUSE OF LANDING
STATIC RPM	.....	.....	WIND	.....MPH	LAUNCHING MEANS	
AIR RPM	.....	.....	Launching SPEED	.....MPH	GROUND TEMP.	

LAUNCHING CHARACTERISTICS

DAMAGES

EQUIPMENT UNDER TEST

Radio Receiver-Transmitter RT-178/ARC-27 in conjunction with tail cap antenna

PURPOSE OR DESCRIPTION OF FLIGHT

To obtain antenna pattern for tail cap antenna while flying a 30-degree clover-leaf pattern

TEST PROCEDURE AND/OR FLIGHT PROGRAM

Climb to 35,000 feet at 35 miles 180° Ground Station AF5XX. Fly a 30° clover-leaf pattern this point reporting at same on every leg of pattern. Ground Station AF5XX will record signal strengths. Frequencies to be tested are 229.2, 316.2, and 385.6 megacycles.

TEST DATA AND/OR RESULTS

Flight test was completed on this run and recordings were posted in the project record book. Two-way communication was good throughout test flight. Signal strength was 3 microvolts or better throughout entire flight test.

FIGURE 10

FLIGHT TEST RECORD
30-degree Clover-Leaf Pattern

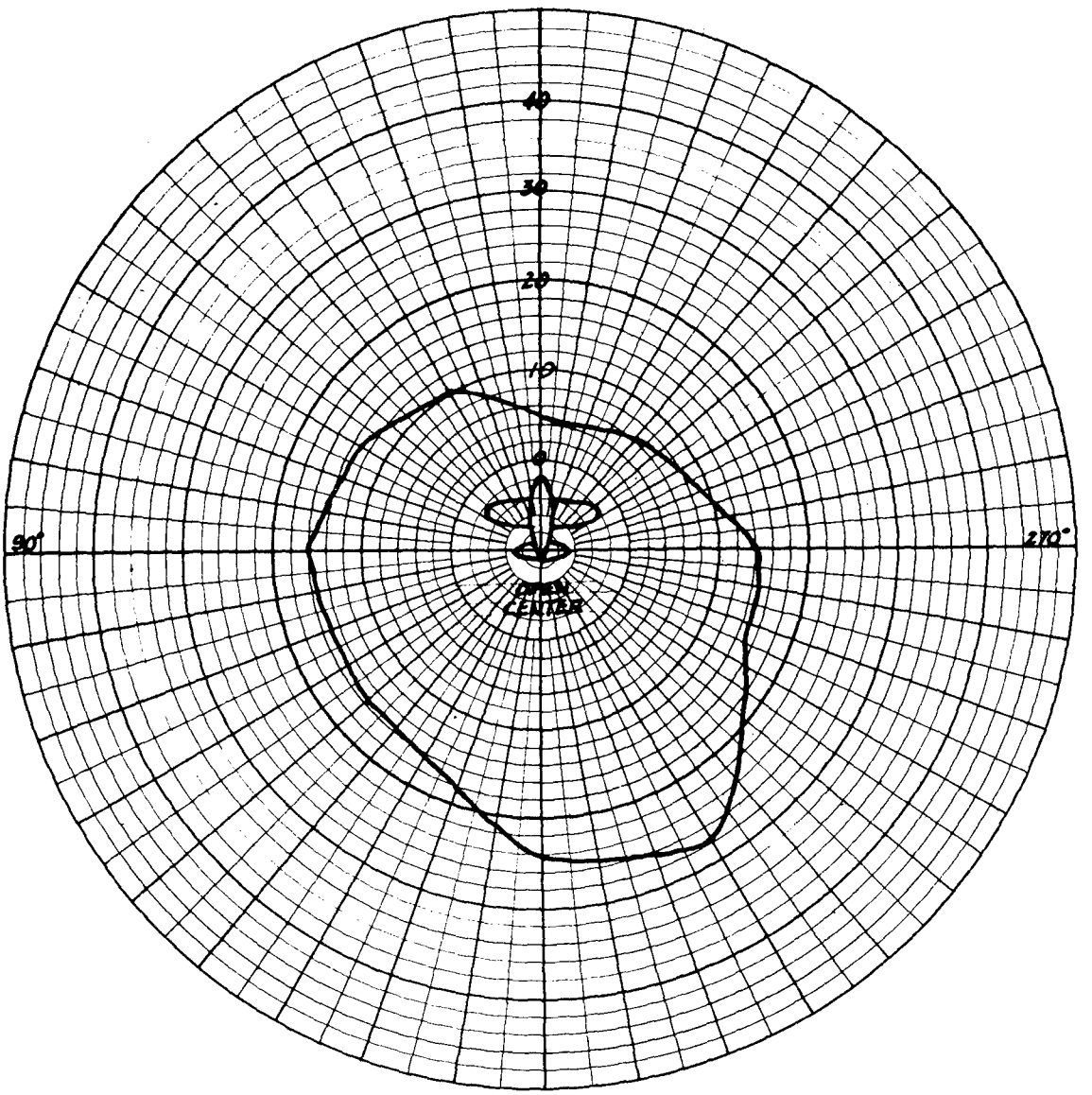

FIGURE 11

POLAR PLOT, 30-DEGREE CLOVER-LEAF PATTERN, 385.6 MEGACYCLES

Scale: 1 Division = .5 Microvolts

PATTERN---30-Degree Clover-leaf

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---35 Statute Miles

ELEVATION ANGLE---10.9°

FREQUENCY---385.6 Megacycles

TRANSMITTER POWER OUTPUT---10.5 Watts

DATE---16 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication good over entire 360 degrees

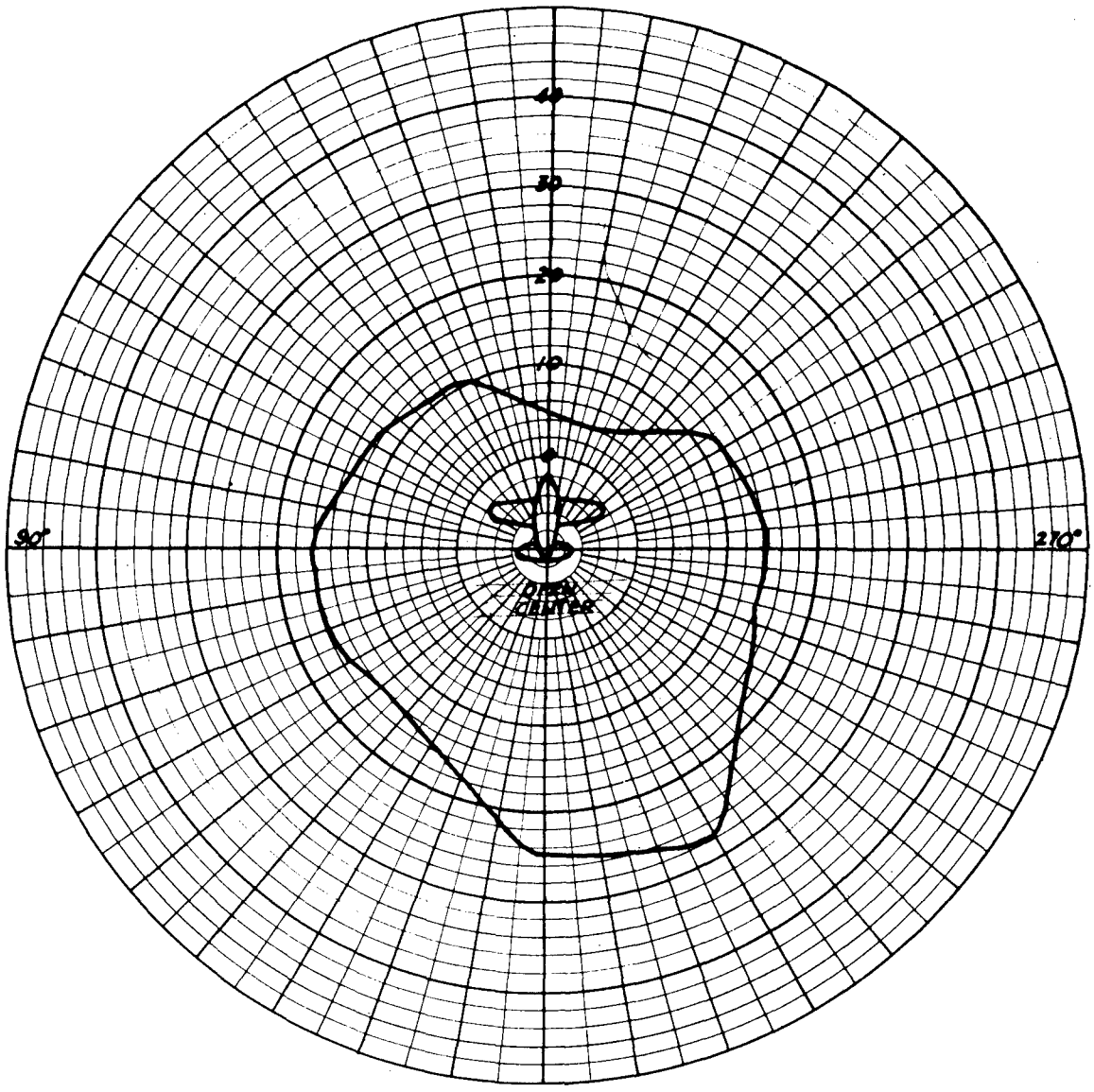

FIGURE 12

POLAR PLOT, 30-DEGREE CLOVER-LEAF PATTERN, 316.2 MEGACYCLES

Scale: 1 Division = 2 Microvolts

PATTERN---30-Degree Clover-leaf

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---35 Statute Miles

ELEVATION ANGLE---10.9°

FREQUENCY---316.2 Megacycles

TRANSMITTER POWER OUTPUT---15.0 Watts

DATE---16 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication good over entire 360 degrees

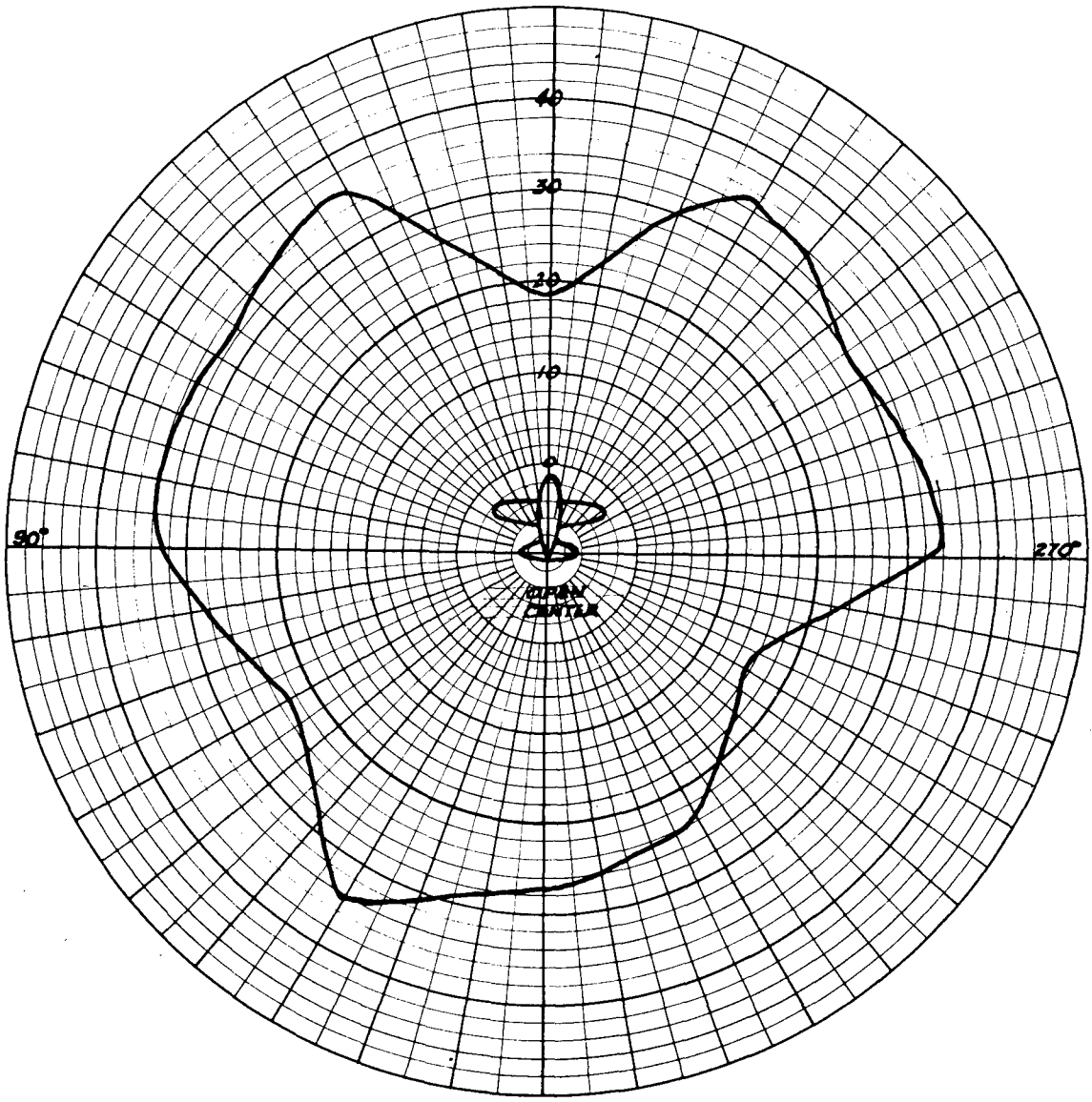

FIGURE 13

POLAR PLOT, 30-DEGREE CLOVER-LEAF PATTERN, 229.2 MEGACYCLES

Scale: 1 Division = 2 Microvolts

PATTERN---30-Degree Clover-leaf

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---35 Statute Miles

ELEVATION ANGLE---10.9°

FREQUENCY---229.2 Megacycles

TRANSMITTER POWER OUTPUT---11.5 Watts

DATE---16 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl.

REMARKS---Two-way communication good over entire 360 degrees

AIRPLANE TYPE & NO.	FLIGHT NO.	REPORT SERIAL NO.	DATE	TIME
F-94A-2584	1		7 Feb. 1952	TAKE-OFF 1210
LOCATION – ☒ LOCAL ☐ CROSS-COUNTRY			MAX. ALTITUDE 35,000 Ft.	LANDING 1330
				TOTAL FLIGHT 1+20
WEATHER VFR-Mostly Cloudy				TOTAL ON EQUIP. 1+20
				PILOT Lt. A. B. Crouch
PROJECT Tail Cap Antenna Evaluation			E. O. NO. S-102-54	CO-PILOT
				OBSERVERS

FOR USE ONLY ON REMOTELY-CONTROLLED AIRCRAFT

TYPE OF PROPELLER	ENGINE TYPE & NO.	RADIO	SERVO

	Variable	Steady				CAUSE OF LANDING
STATIC RPM	.....	.....	WIND	.....MPH	LAUNCHING MEANS	
AIR RPM	.....	.....	Launching SPEED	.....MPH	GROUND TEMP.	

LAUNCHING CHARACTERISTICS

DAMAGES

EQUIPMENT UNDER TEST
Radio Receiver-Transmitter RT-178/ARC-27 in conjunction with the tail cap antenna

PURPOSE OR DESCRIPTION OF FLIGHT To obtain signal strength reading from 8-sided (45-degree) clover-leaf patterns at a range of 10 miles at 35,000 feet altitude, due south of Ground Station AF5XX, on three test frequencies

TEST PROCEDURE AND/OR FLIGHT PROGRAM
Take off, climb to 35,000 feet. Locate a ground check point 10 miles due south of this station. Fly an 8-sided (45-degree) clover-leaf pattern directly over the check point. When passing over the point, inform station AF5XX and hold carrier on for approximately three seconds. Repeat this pattern for each of following three test frequencies: 229.2, 316.2, and 385.6 megacycles.

TEST DATA AND/OR RESULTS
Three clover-leaf patterns were flown, and the signal strength was recorded for all headings and all three frequencies. After landing, the pilot reported that the last pattern (385.6 megacycles) was flown at much greater range than the required 10-mile range. The pilot estimated the maximum range to be approximately 35 miles; however, there was almost a complete cloud layer present which made it almost impossible to locate the ground check point with any degree of accuracy. The exact range of the other two patterns flown(Figs. 16 and 17) is questionable.

FIGURE 14

FLIGHT TEST RECORD
45-degree Clover-Leaf Pattern

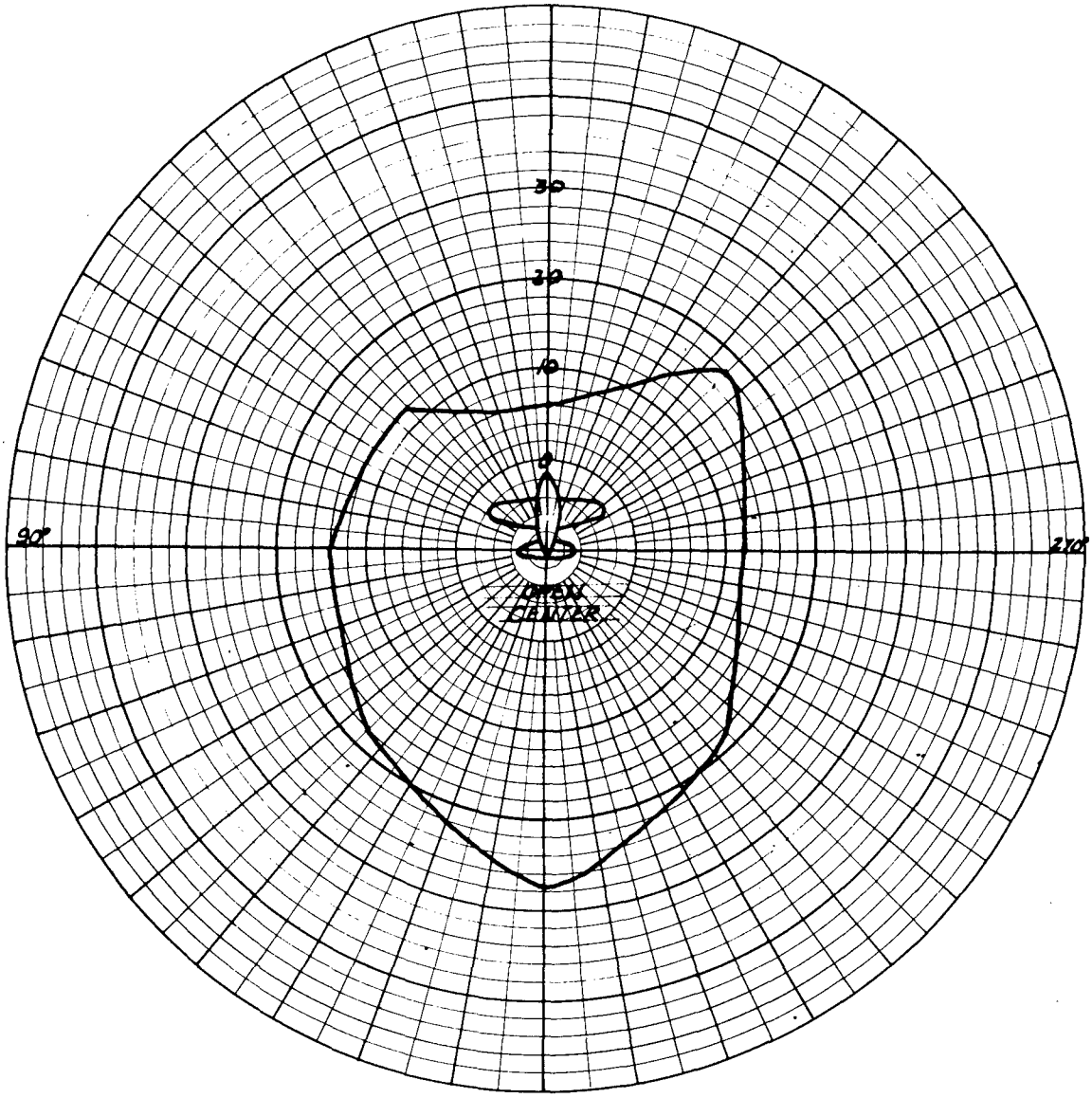

FIGURE 15

POLAR PLOT, 45-DEGREE CLOVER-LEAF PATTERN, 385.6 MEGACYCLES

Scale: 1 Division = 2 Microvolts

PATTERN---45-Degree Clover-leaf

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---10 Statute Miles

ELEVATION ANGLE---31.3°

FREQUENCY---385.6 Megacycles

TRANSMITTER POWER OUTPUT---10.5Watts

DATE---6 February 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication good throughout entire flight pattern

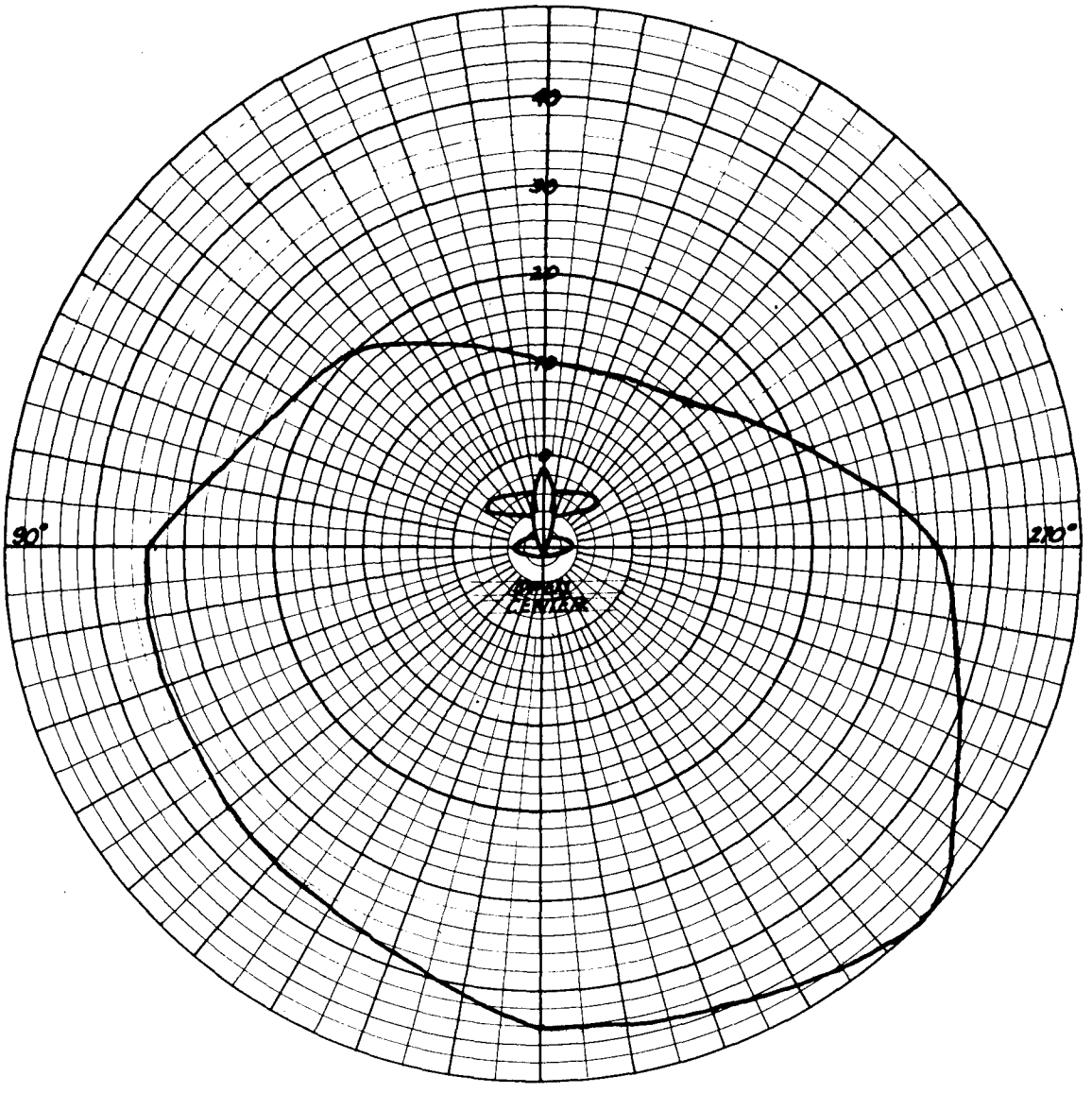

FIGURE 16

POLAR PLOT, 45-DEGREE CLOVER-LEAF PATTERN, 316.2 MEGACYCLES

Scale: 1 Division = 2 Microvolts

PATTERN---45-Degree Clover-leaf

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---10 Statute Miles

ELEVATION ANGLE---31.3°

FREQUENCY---316.2 Megacycles

TRANSMITTER POWER OUTPUT---15.0 Watts

DATE---7 February 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS: Two-way communication was good throughout entire flight pattern

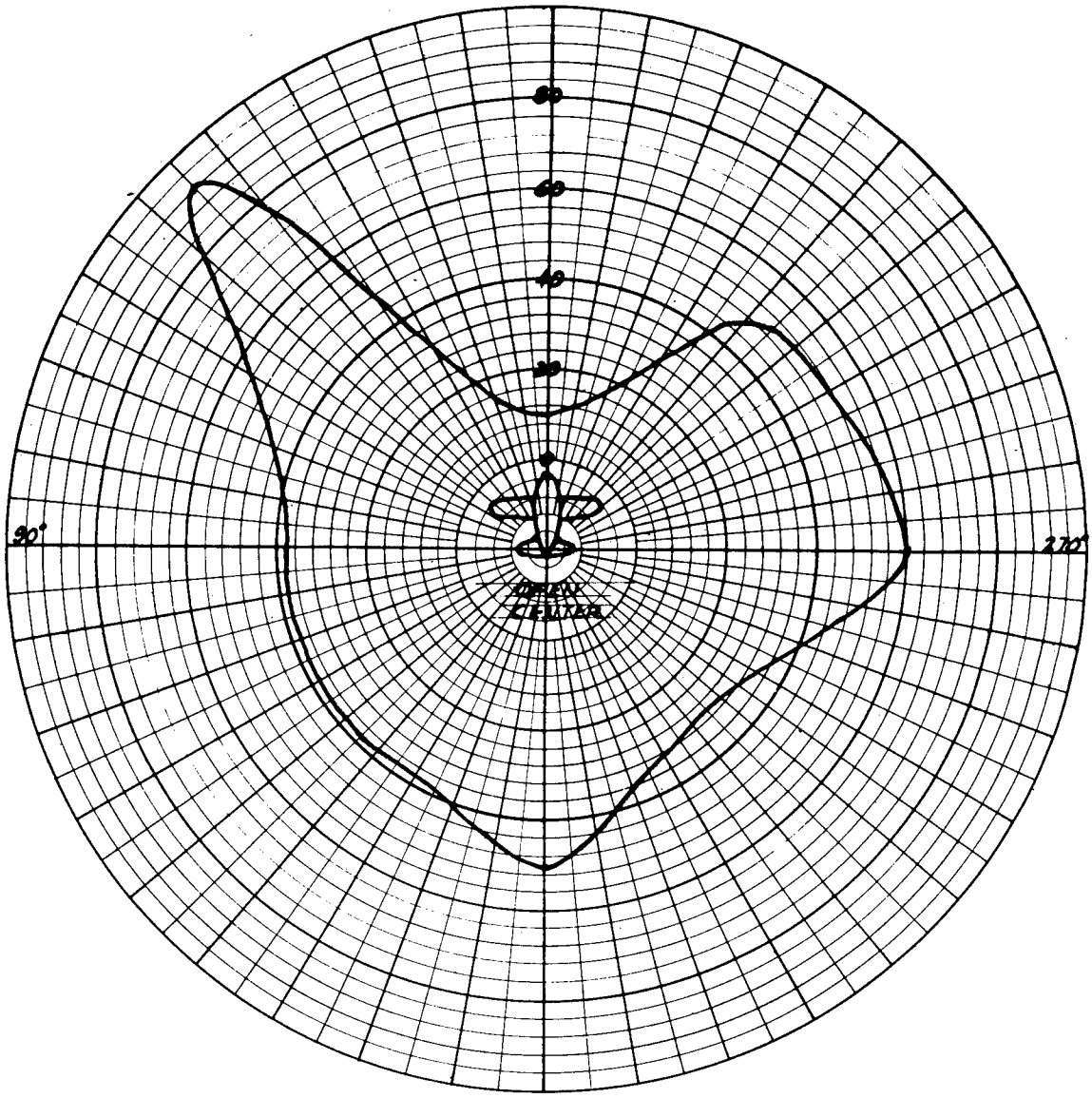

FIGURE 17

POLAR PLOT, 45-DEGREE CLOVER-LEAF PATTERN, 229.2 MEGACYCLES

Scale: 1 Division = 4 Microvolts

PATTERN---45-Degree Clover-leaf

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---10 Statute Miles

ELEVATION ANGLE---31.3°

FREQUENCY---229.2 Megacycles

TRANSMITTER POWER OUTPUT---11.5 Watts

DATE---7 February 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication good throughout entire flight pattern

AIRPLANE TYPE & NO.	FLIGHT NO.	REPORT SERIAL NO.	DATE	TIME
F-94A-2584	1	1	18 Jan. 1952	TAKE-OFF 0825
LOCATION – ☒ LOCAL ☐ CROSS-COUNTRY			MAX. ALTITUDE	LANDING 0950
			10,000 Feet	TOTAL FLIGHT 1+25
WEATHER				TOTAL ON EQUIP. 1+25
VFR				PILOT Lt. A. B. Crouch
PROJECT			E. O. NO.	CO-PILOT
Tail Cap Antenna Evaluation, UHF			S-102-54	OBSERVERS

FOR USE ONLY ON REMOTELY-CONTROLLED AIRCRAFT

TYPE OF PROPELLER	ENGINE TYPE & NO.	RADIO	SERVO

	Variable	Steady				CAUSE OF LANDING
STATIC RPM	.....	.....	WIND ..... MPH	LAUNCHING MEANS		
AIR RPM	.....	.....	Launching SPEED ..... MPH	GROUND TEMP.		

LAUNCHING CHARACTERISTICS

DAMAGES

EQUIPMENT UNDER TEST

Radio Receiver-Transmitter RT-178/ARC-27 in conjunction with tail cap antenna

PURPOSE OR DESCRIPTION OF FLIGHT

To obtain an antenna pattern at a low angle from Ground Station AF5XX of tail cap antenna while flying a 30-degree clover-leaf pattern.

TEST PROCEDURE AND/OR FLIGHT PROGRAM

Climb to 10,000 feet at 30 miles at a heading of 180° from station, fly a 30-degree clover-leaf pattern and report to station on every leg of pattern over point. Station AF5XX will record signal strength. Frequencies to be tested are 229.2, 316.2, and 385.6 megacycles.

TEST DATA AND/OR RESULTS

Test pattern was completed and corresponding signal strengths recorded in project record book. Two-way communication was good throughout entire flight. Signal strength was three microvolts or better throughout test flight.

FIGURE 18

FLIGHT TEST RECORD

30-degree Clover-Leaf Pattern

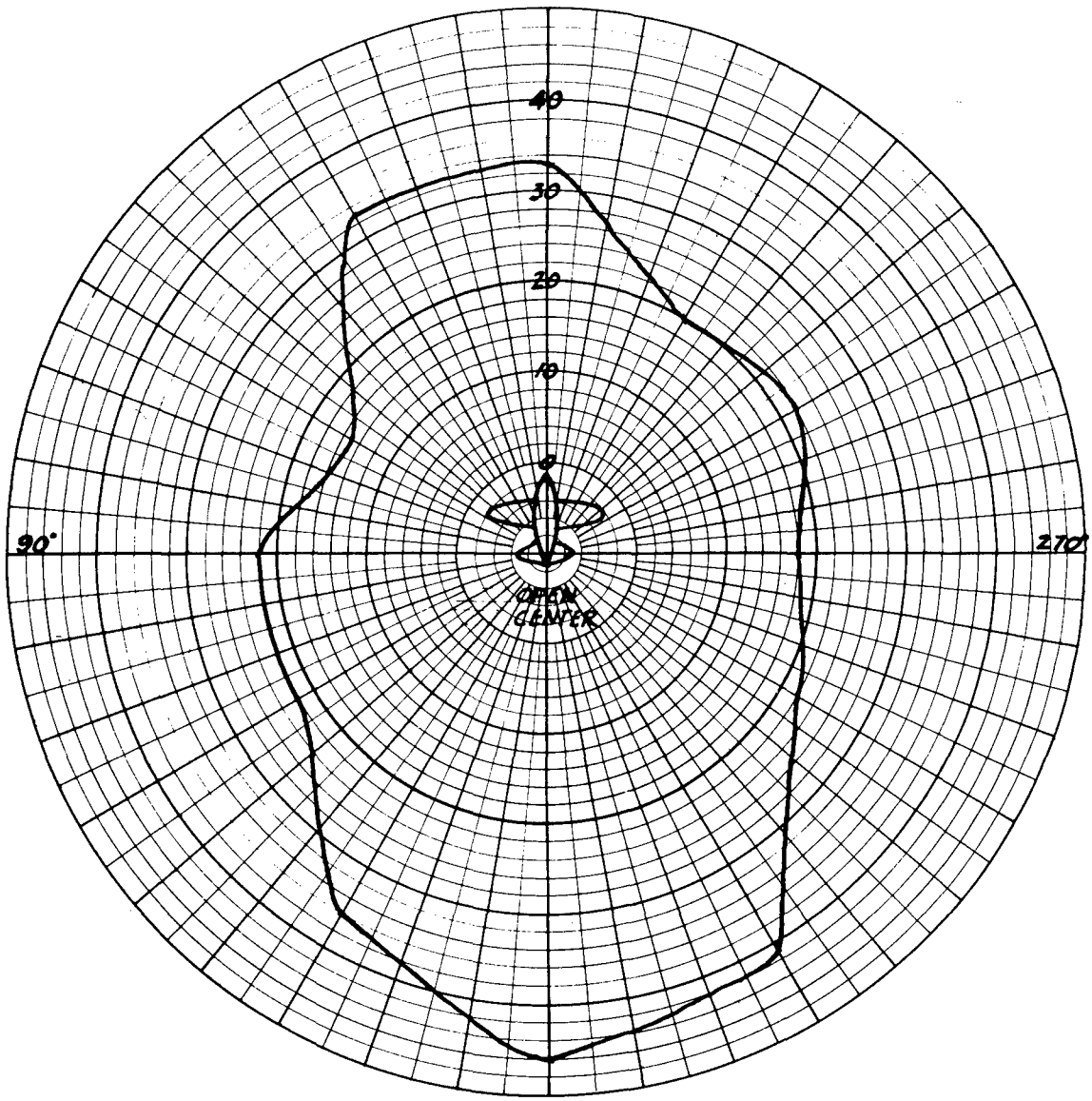

FIGURE 19

POLAR PLOT, 30-DEGREE CLOVER-LEAF PATTERN, 385.6 MEGACYCLES, ELEVATION ANGLE 3.62°

Scale: 1 Division = 2 Microvolts

PATTERN---30Degree Clover-leaf

ALTITUDE---10,000 Ft. (Pressure)

DISTANCE---30 Statute Miles

ELEVATION ANGLE---3.62°

FREQUENCY---385.6 Megacycles

TRANSMITTER POWER OUTPUT---11.5 Watts

DATE---18 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication good throughout flight test

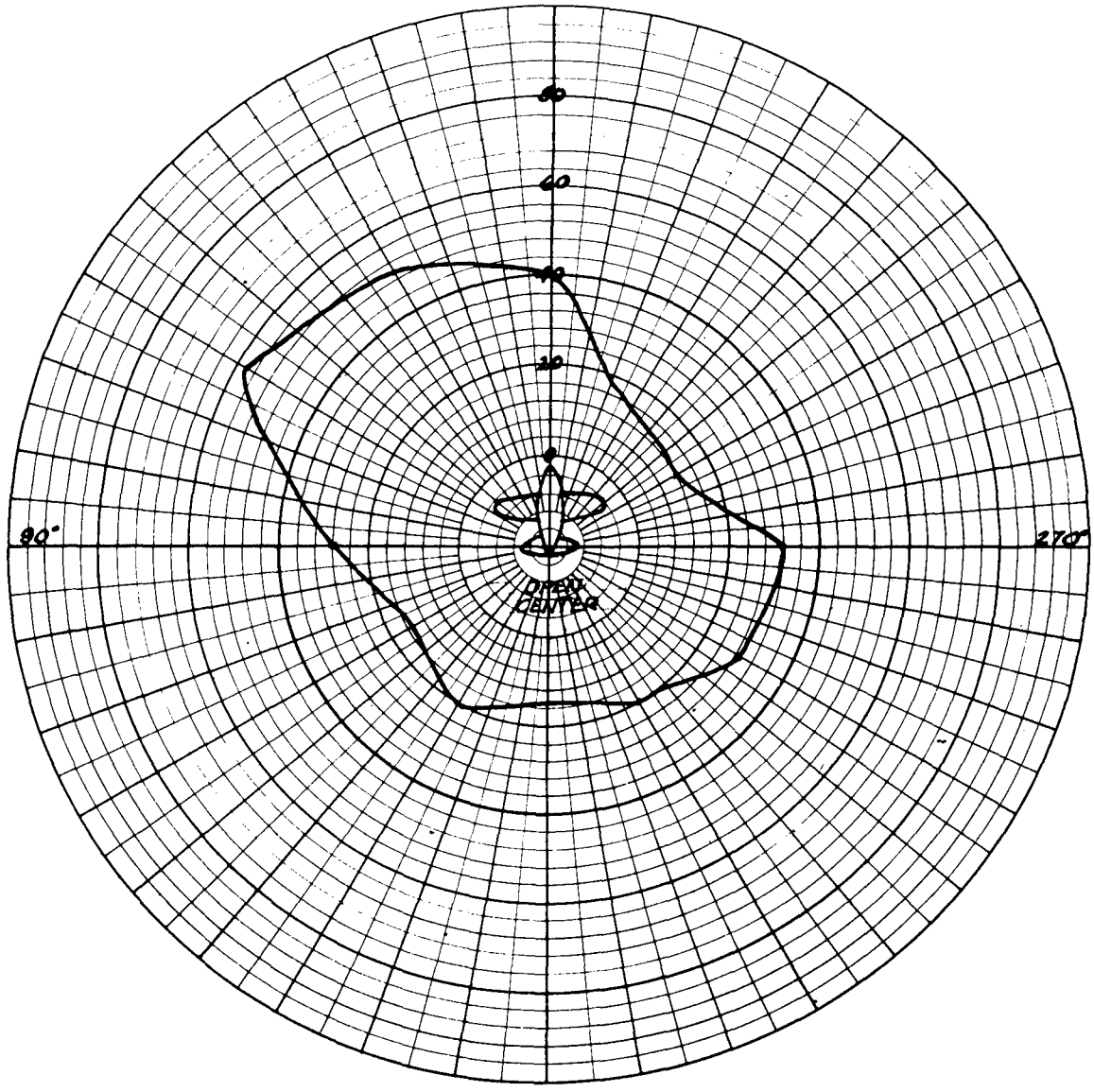

FIGURE 20

POLAR PLOT, 30-DEGREE CLOVER-LEAF PATTERN, 229.2 MEGACYCLES, ELEVATION ANGLE 3.62°

Scale: 1 Division = 4 Microvolts

PATTERN---30-Degree Clover-leaf

ALTITUDE---10,000 Ft. (Pressure)

DISTANCE---30 Statute Miles

ELEVATION ANGLE---3.62°

FREQUENCY---229.2 Megacycles

TRANSMITTER POWER OUTPUT---11.5 Watts

DATE---18 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication good throughout flight test

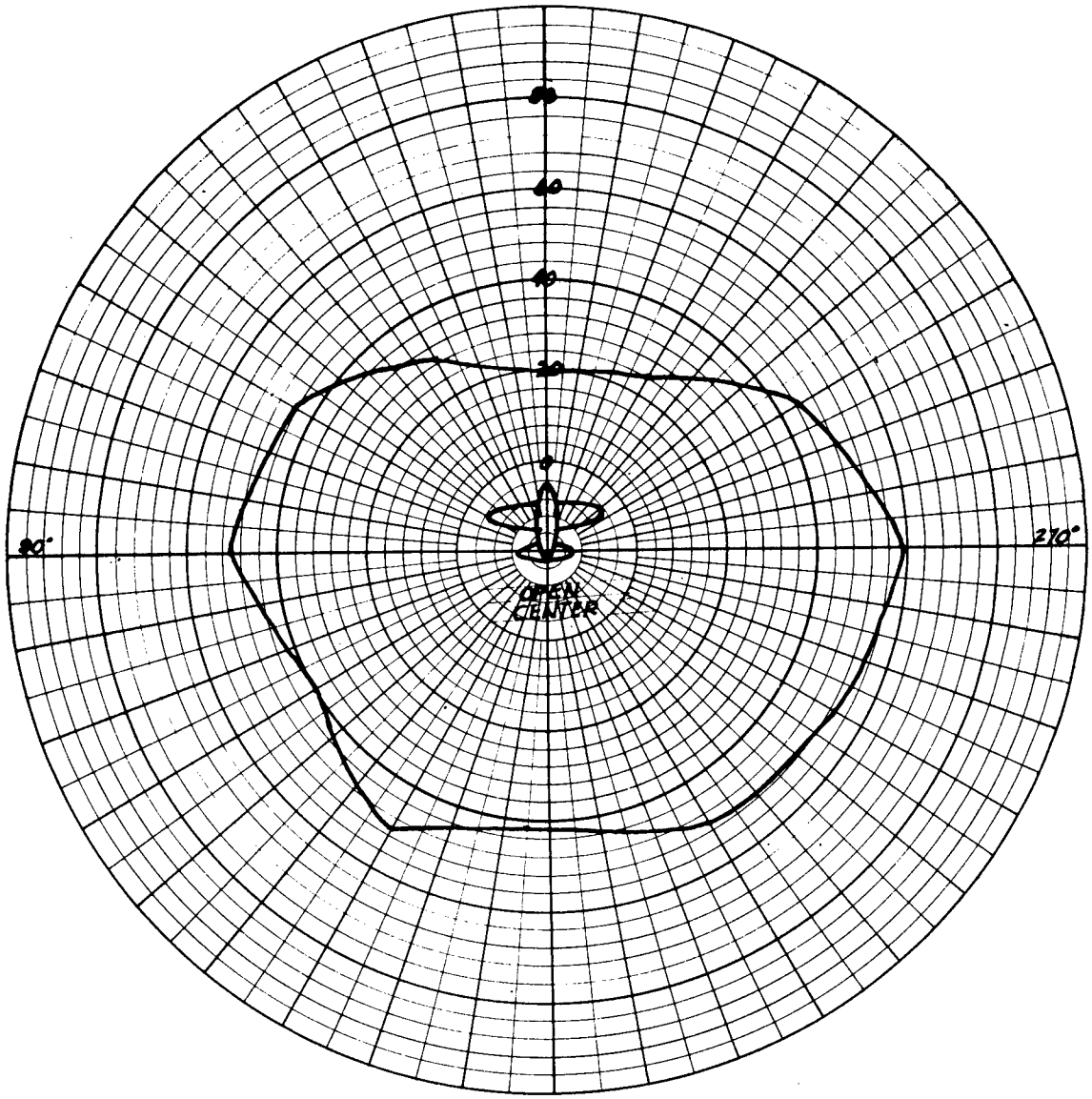

FIGURE 21

POLAR PLOT, 30-DEGREE CLOVER-LEAF PATTERN, 316.2 MEGACYCLES, ELEVATION ANGLE 3.62°

Scale: 1 Division = 4 Microvolts

PATTERN---30-Degree Clover-leaf

ALTITUDE---10,000 Ft. (Pressure)

DISTANCE---30 Statute Miles

ELEVATION ANGLE---3.62°

FREQUENCY---316.2 Megacycles

TRANSMITTER POWER OUTPUT---11.5 Watts

DATE---18 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication good throughout entire flight pattern

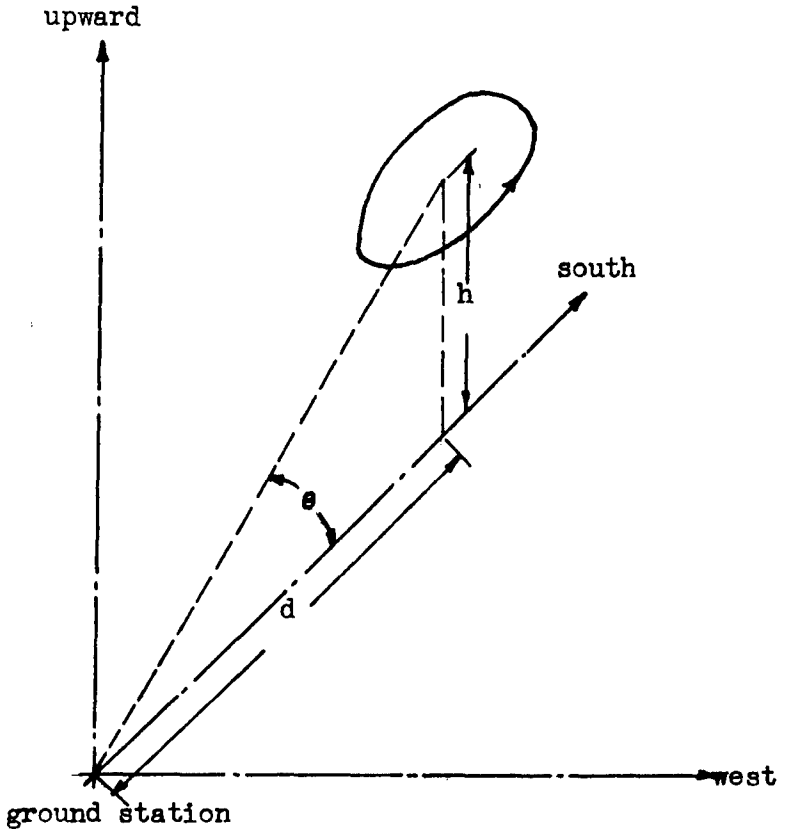

FIGURE 22

PLANE FIGURE, 36-SIDED

Key

h--Altitude of flight pattern
d--Distance of reference point from ground station
θ--Arc tan $\frac{h}{d}$ altitude of aircraft with respect to ground station

Patterns were flown at the following attitudes
θ=12.75° θ=10.9° θ=8.4° θ=3.8° θ=1.2°

Typical flight pattern showing the relative positions of the aircraft and Ground Station AF5XX while a 36-sided plane figure is being flown. Ground station questioned and pilot answered (two-way) on each straight and level leg of the figure. See figure 47.

AIRPLANE TYPE & NO.	FLIGHT NO.	REPORT SERIAL NO.	DATE	TIME
F-94A-2584	2		15 Jan. 1952	TAKE-OFF 1100
LOCATION — [X] LOCAL [ ] CROSS-COUNTRY			MAX. ALTITUDE 35,000 Ft.	LANDING 1215 TOTAL FLIGHT 1+15
WEATHER VFR				TOTAL ON EQUIP. 1+15 PILOT Lt. A.B. Crouch
PROJECT Tail cap antenna evaluation, UHF			E. O. NO. S-102-54	CO-PILOT OBSERVERS

FOR USE ONLY ON REMOTELY-CONTROLLED AIRCRAFT

TYPE OF PROPELLER	ENGINE TYPE & NO.	RADIO	SERVO

	Variable	Steady				CAUSE OF LANDING
STATIC RPM	.....	.....	WIND	.....MPH	LAUNCHING MEANS	
AIR RPM	.....	.....	Launching SPEED	.....MPH	GROUND TEMP.	

LAUNCHING CHARACTERISTICS

DAMAGES

EQUIPMENT UNDER TEST
Radio Receiver-Transmitter RT-178/ARC-27 in conjunction with tail cap antenna

PURPOSE OR DESCRIPTION OF FLIGHT
To obtain antenna patterns at 100 miles range of tail cap antenna at 11,000 feet for frequencies of 229.2, 316.2, and 385.6 megacycles, and to obtain antenna patterns at 45 miles range of tail cap antenna at 35,000 feet for 229.2, 316.2, and 385.6 megacycles (frequencies).

TEST PROCEDURE AND/OR FLIGHT PROGRAM
Climb to 10,000 feet terrain clearance, fly 180° of Ground Station AF5XX to range of 100 miles, fly 360° skid-turn this point, report heading every 10° and hold carrier wave on for approximately three seconds while keeping altitude level. Station AF5XX will record signal strengths. Repeat above procedure at 35,000 feet at 45-mile range.

TEST DATA AND/OR RESULTS
Flight patterns were flown as planned and recordings were taken of signal strengths. At 35,000 feet and 45 miles, communication was good throughout and signal strength was greater than three microvolts throughout. At 11,000 feet and 100 miles, communication was adequate throughout although, at all three frequencies tested, signal strength fell below three microvolts.

FIGURE 23

FLIGHT TEST RECORD

Skid Turn, 36-sided Pattern

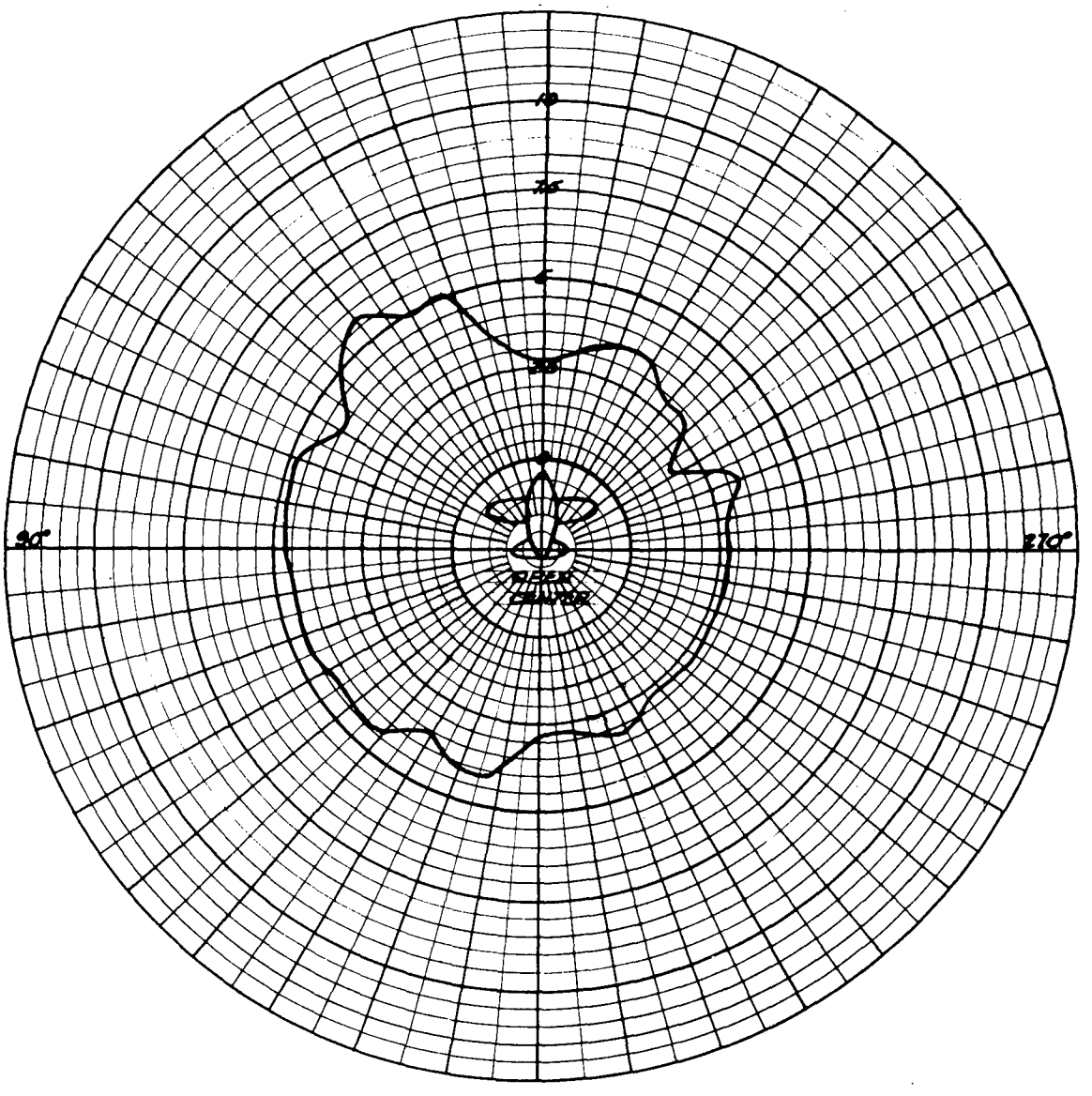

FIGURE 24

POLAR PLOT, SKID TURN, 385.6 MEGACYCLES, ELEVATION ANGLE 1.2°

Scale: 1 Division = .5 Microvolts

PATTERN---Skid Turn

ALTITUDE---11,000 Ft. (Pressure)

DISTANCE---100 Statute Miles

ELEVATION ANGLE---1.2°

FREQUENCY---385.6 Megacycles

TRANSMITTER POWER OUTPUT---15 Watts

DATE---15 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was adequate over entire 360 degrees

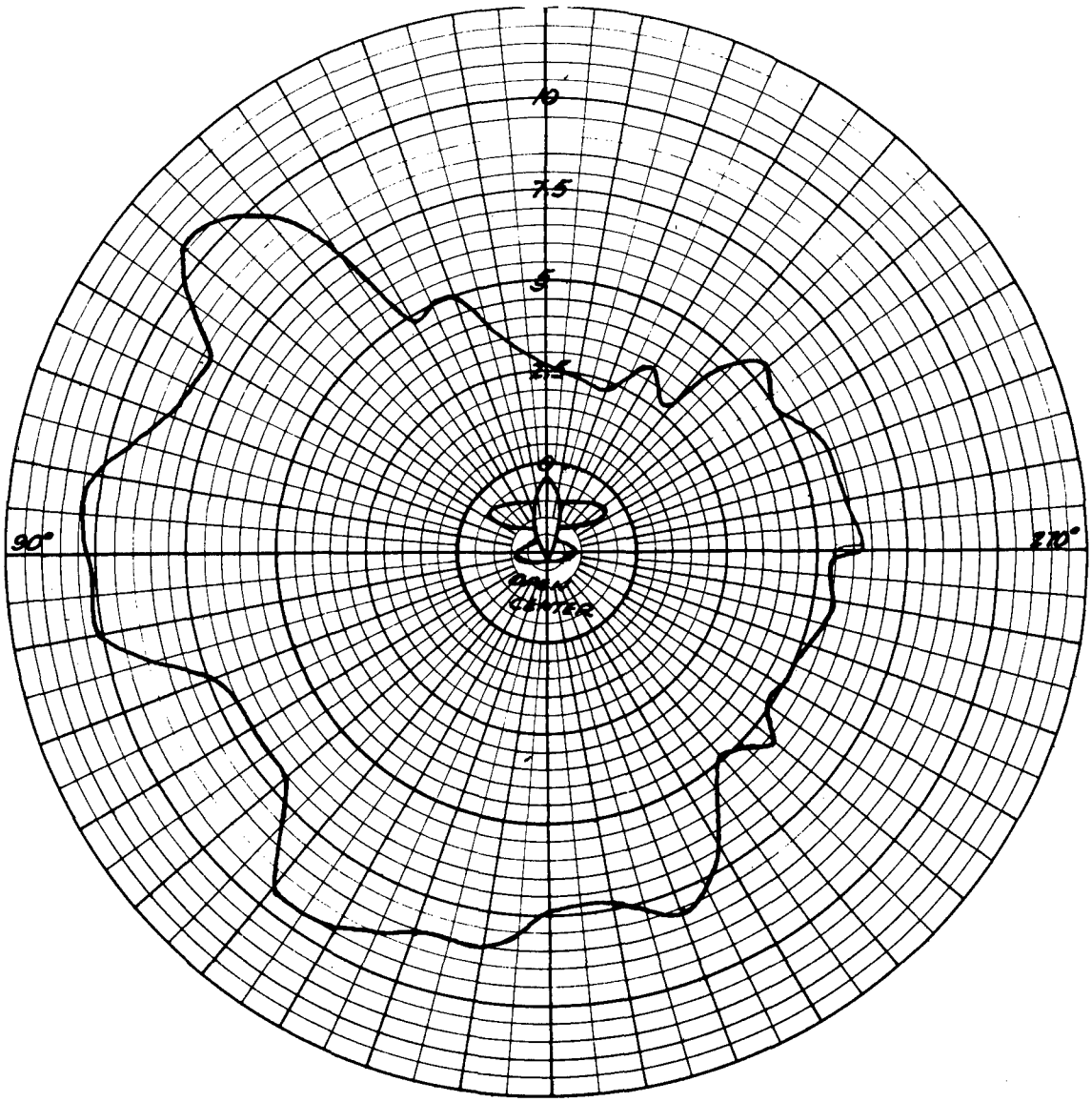

FIGURE 25

POLAR PLOT, SKID TURN, 316.2 MEGACYCLES, ELEVATION ANGLE 1.2°

Scale: 1 Division = .5 Microvolts

PATTERN---Skid Turn

ALTITUDE---11,000 Ft. (Pressure)

DISTANCE---100 Statute Miles

ELEVATION ANGLE---1.2°

FREQUENCY---316.2 Megacycles

TRANSMITTER POWER OUTPUT---15.0 Watts

DATE---15 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was adequate throughout entire flight pattern

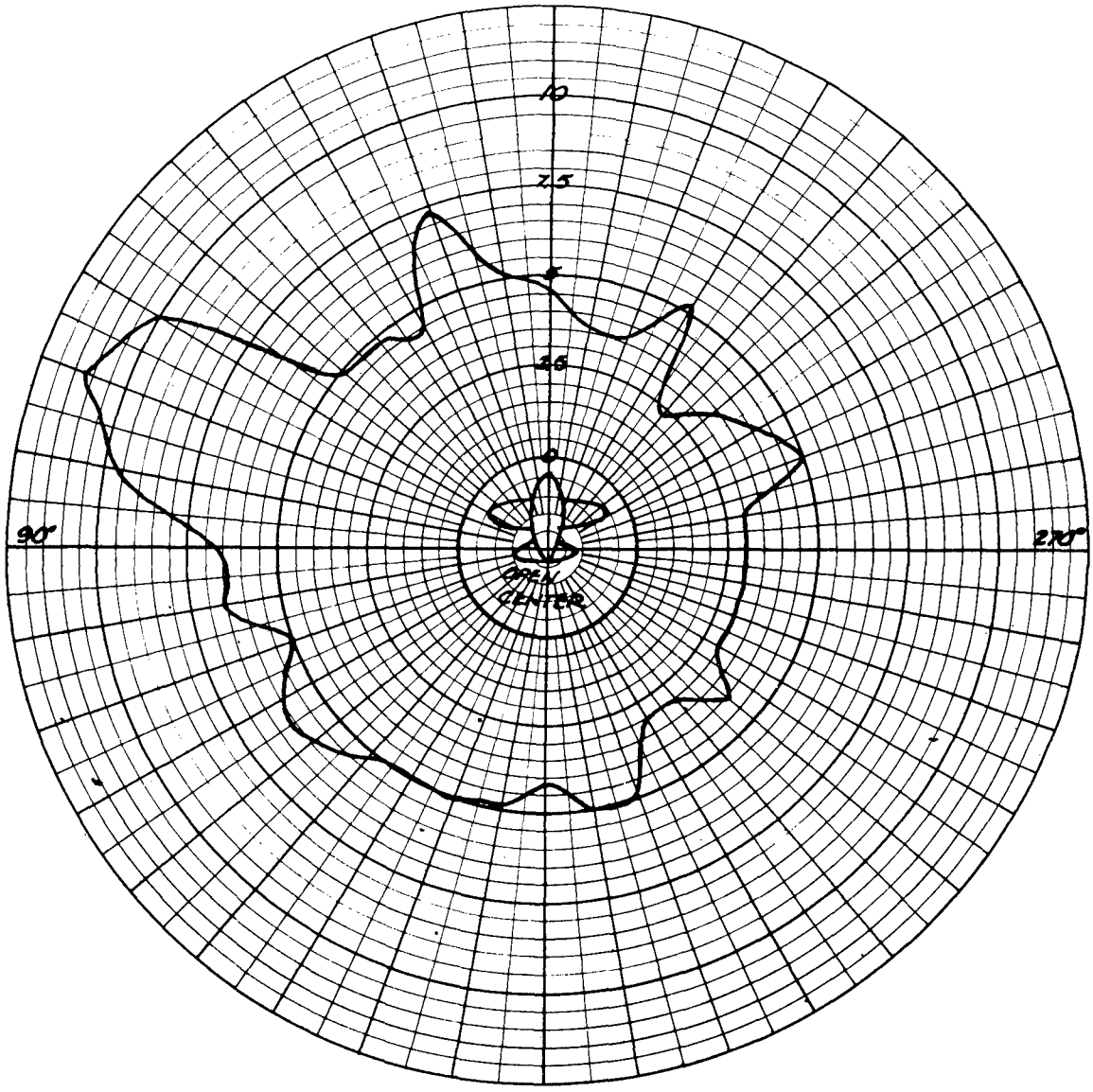

FIGURE 26

POLAR PLOT, SKID TURN, 229.2 MEGACYCLES, ELEVATION ANGLE 1.2°

Scale: 1 Division = .5 Microvolts

PATTERN---Skid Turn

ALTITUDE---11,000 Ft. (Pressure)

DISTANCE---100 Statute Miles

ELEVATION ANGLE---1.2°

FREQUENCY---229.2 Megacycles

TRANSMITTER POWER OUTPUT---11.5 Watts

DATE---15 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was adequate throughout entire flight pattern

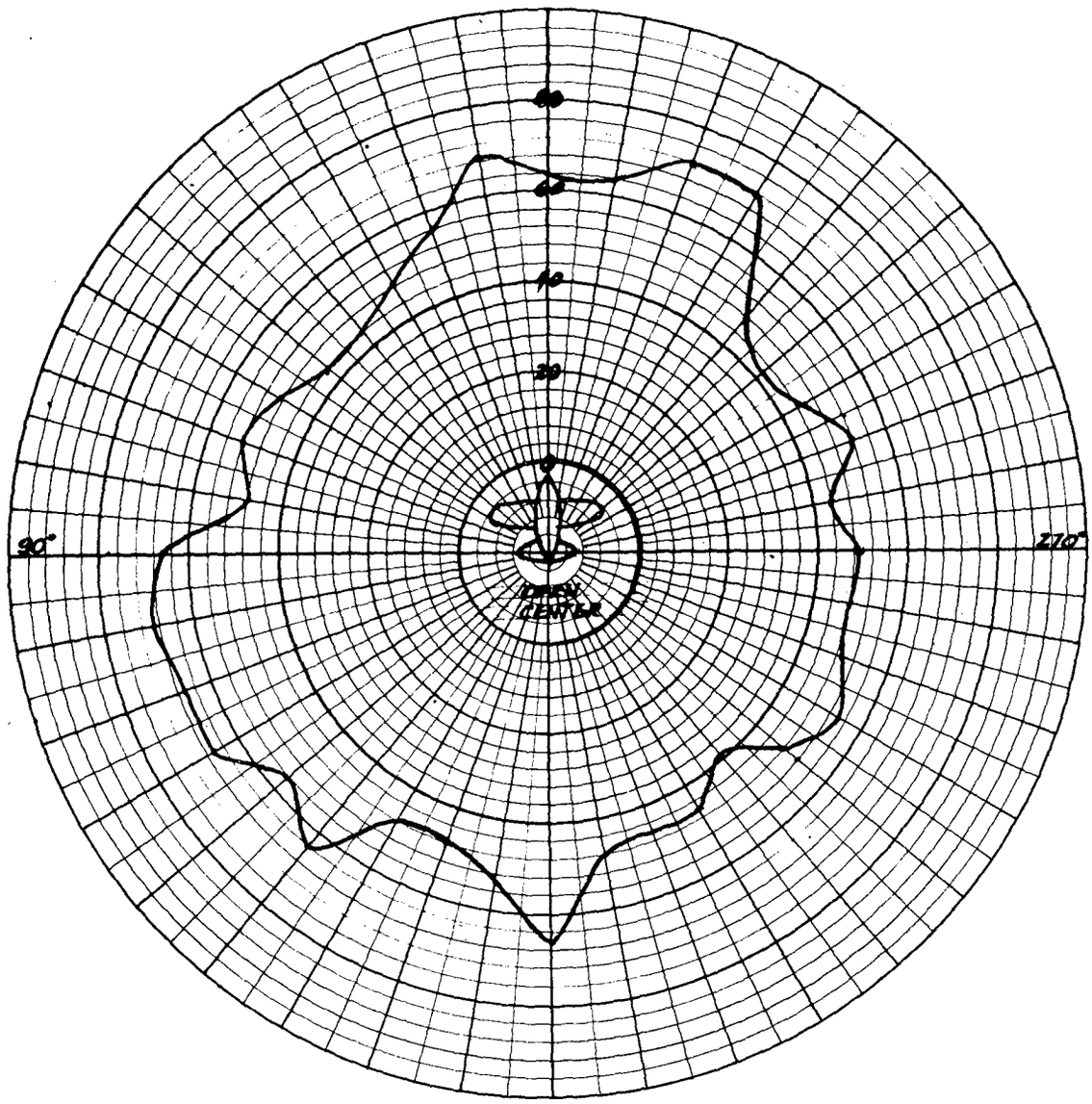

FIGURE 27

POLAR PLOT, SKID TURN, 385.6 MEGACYCLES, ELEVATION ANGLE 8.4°

Scale: 1 Division = 4 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---45 Statute Miles

ELEVATION ANGLE---8.4°

FREQUENCY---385.6 Megacycle

TRANSMITTER POWER OUTPUT---10.5 Watts

DATE---15 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout the entire flight pattern

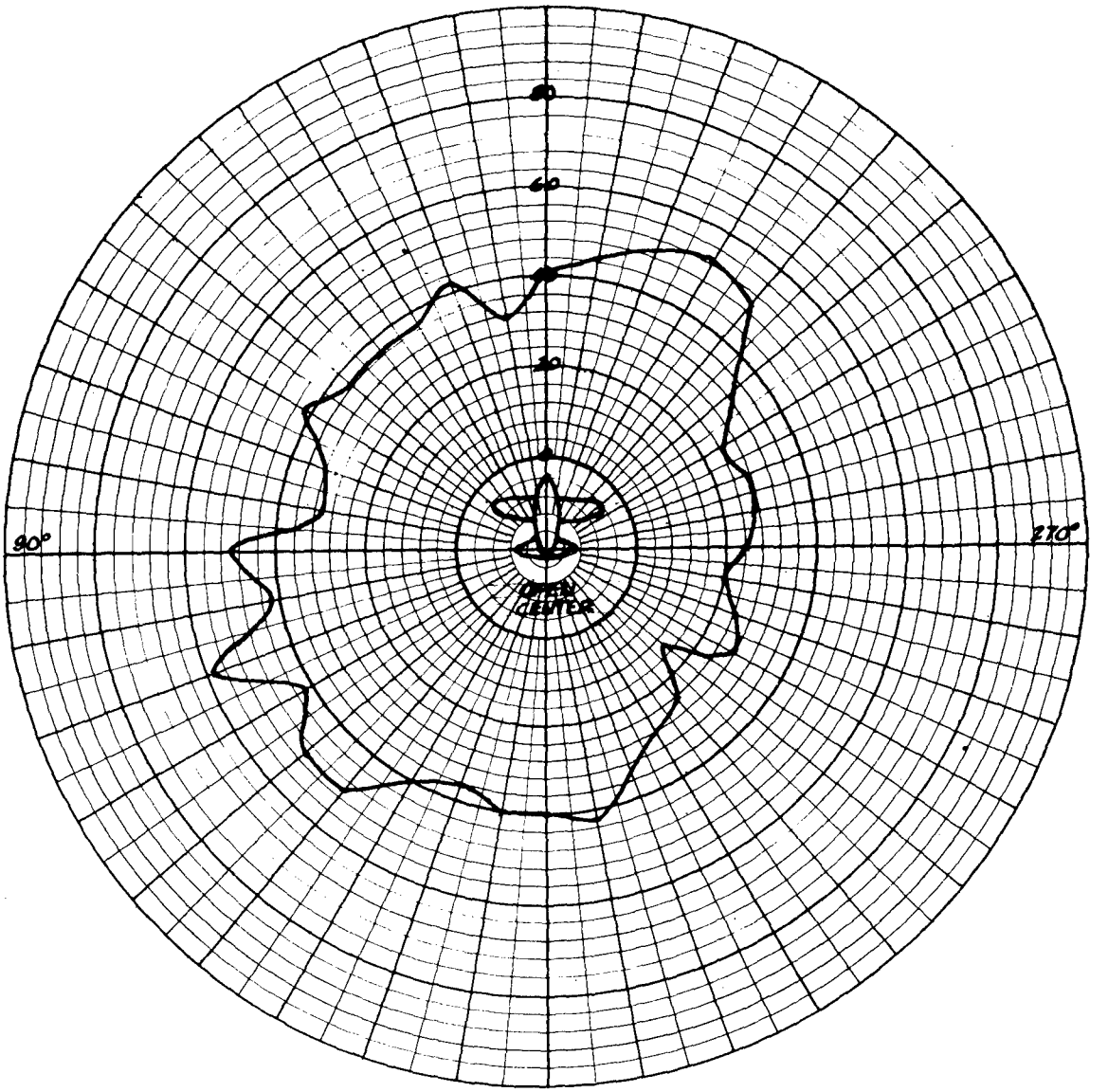

FIGURE 28

POLAR PLOT, SKID TURN, 316.2 MEGACYCLES, ELEVATION ANGLE 8.4°

Scale: 1 Division = 4 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---45 Statute Miles

ELEVATION ANGLE---8.4°

FREQUENCY---316.2 Megacycles

TRANSMITTER POWER OUTPUT---15.0 Watts

DATE---15 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout entire flight pattern

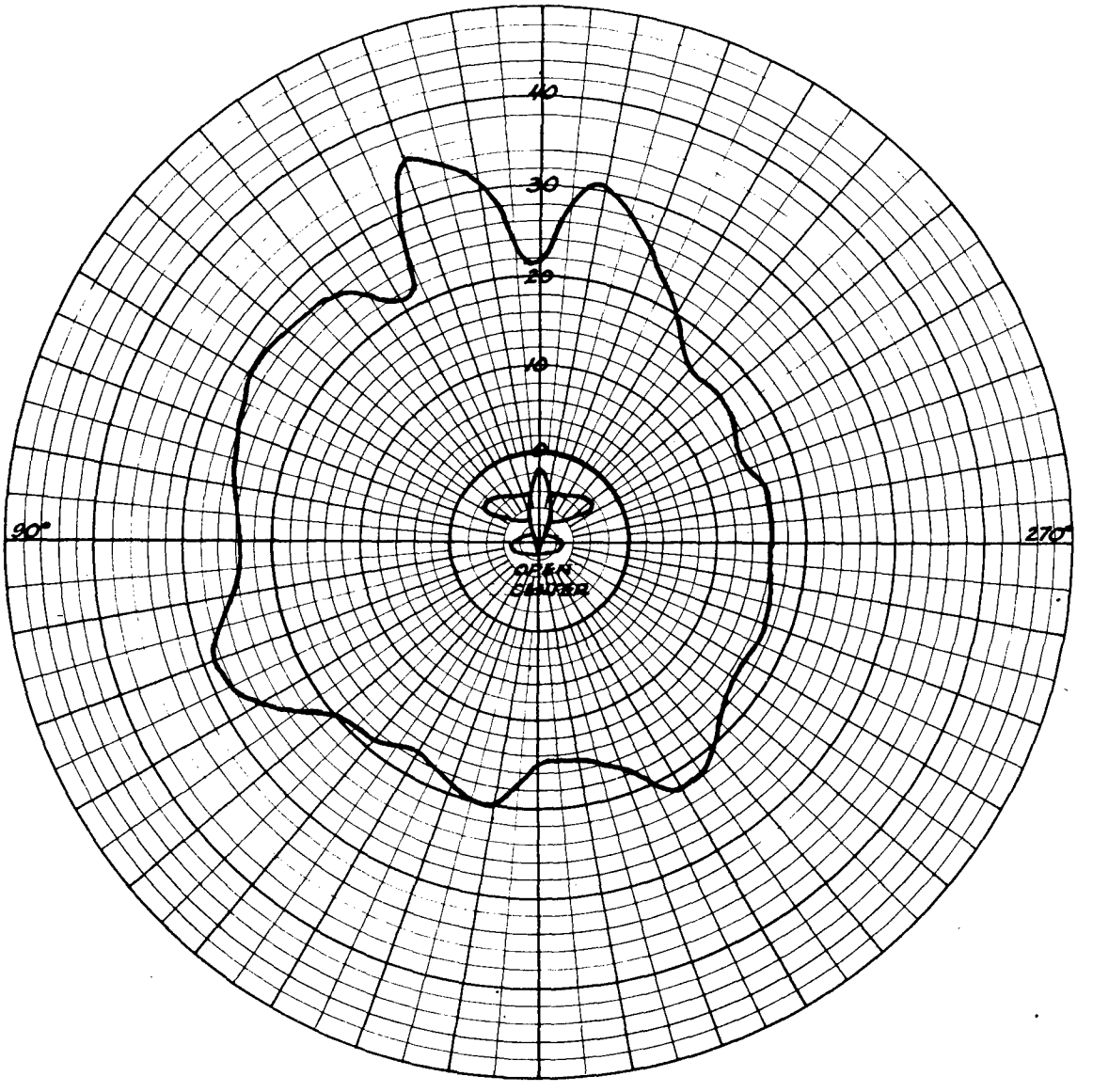

FIGURE 29

POLAR PLOT, SKID TURN, 229.2 MEGACYCLES, ELEVATION ANGLE 8.4°

Scale: 1 Division = 2 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---45 Statute Miles

ELEVATION ANGLE---8.4°

FREQUENCY---229.2 Megacycles

TRANSMITTER POWER OUTPUT---11.5 Watts

DATE---15 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout entire flight pattern

AIRPLANE TYPE & NO.	FLIGHT NO.	REPORT SERIAL NO.	DATE	TIMS
F-94A-2584	1	1	9 Jan. 1952	TAKE-OFF 1345
LOCATION – ☒ LOCAL ☐ CROSS-COUNTRY			MAX. ALTITUDE	LANDING 1520
			35,000 Ft.	TOTAL FLIGHT 1+35
WEATHER				TOTAL ON EQUIP. 1+35
VFR				PILOT Lt. A. B. Crouch
PROJECT			E. O. NO.	CO-PILOT
Tail cap antenna evaluation, UHF			S-102-54	OBSERVERS

FOR USE ONLY ON REMOTELY-CONTROLLED AIRCRAFT

TYPE OF PROPELLER	ENGINE TYPE & NO.	RADIO	SERVO

	Variable	Steady				CAUSE OF LANDING
STATIC RPM	.....	.....	WIND	.....MPH	LAUNCHING MEANS	
AIR RPM	.....	.....	Launching SPEED	.....MPH	GROUND TEMP.	

LAUNCHING CHARACTERISTICS

DAMAGES

EQUIPMENT UNDER TEST

Radio Receiver-Transmitter RT-178/ARC-27 in conjunction with tail cap antenna

PURPOSE OR DESCRIPTION OF FLIGHT

To test the tail cap antenna pattern on a skid turn at low degree with respect to Ground Station AF5XX

TEST PROCEDURE AND/OR FLIGHT PROGRAM

Fly to a point 100 miles at 180° heading and climb to 35,000 feet. The pilot will fly a 360-degree skid turn pattern and will report to station at 10-degree increments while keeping the altitude level. Frequencies to be tested were 229.2, 316.2, and 385.6 megacycles. Repeat the above procedure at 35,000 feet and 35 miles.

TEST DATA AND/OR RESULTS

Tests were flown under specified conditions and signal strength recordings were taken and recorded in project record book. Two-way communication was good throughout all flights. Signal strength was three microvolts or better on all frequencies.

FIGURE 30

FLIGHT TEST RECORD

Skid Turn Pattern

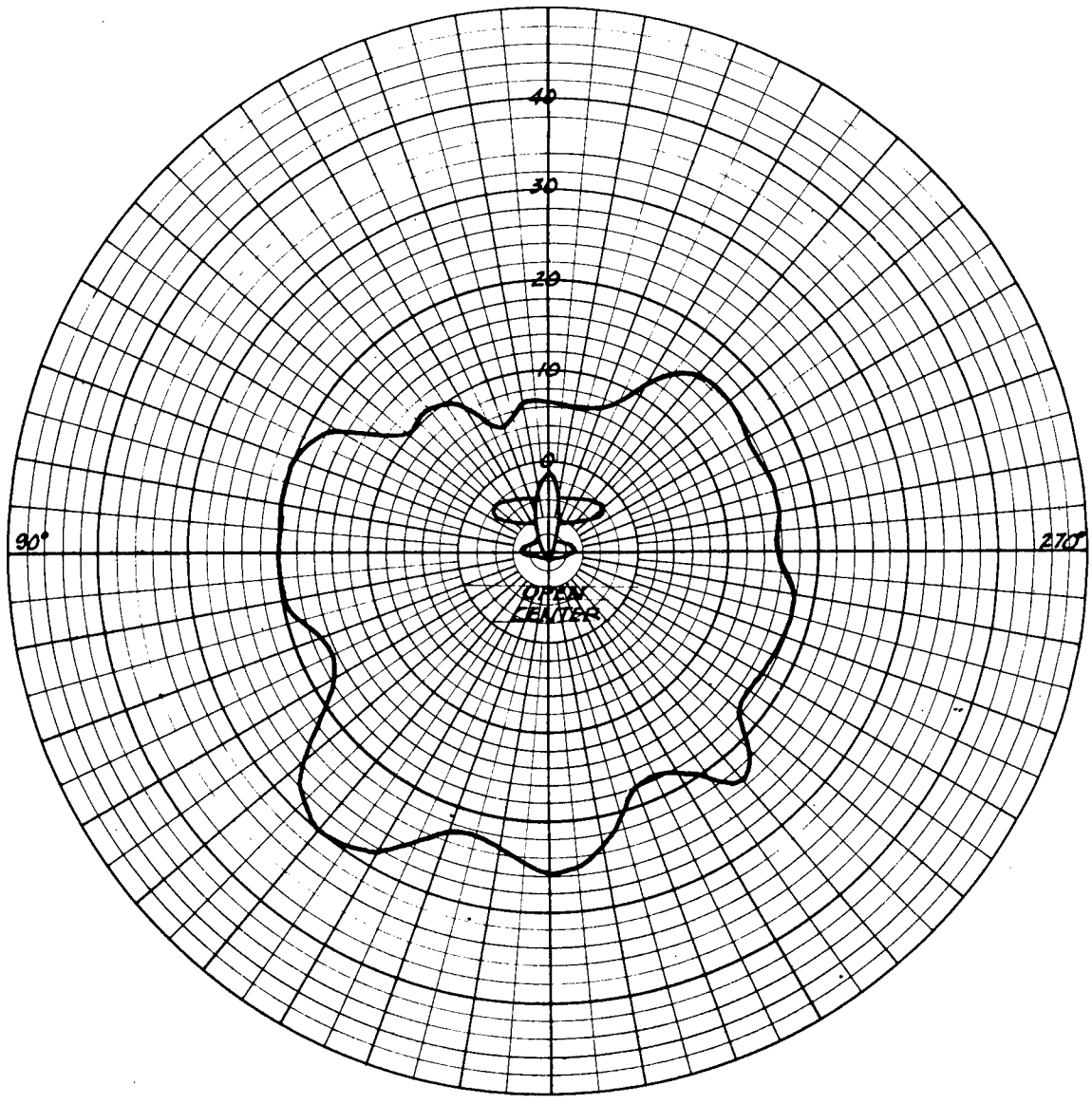

FIGURE 31

POLAR PLOT, SKID TURN, 385.6 MEGACYCLES, ELEVATION ANGLE 10.9°

Scale: 1 Division = 2 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---35 Statute Miles

ELEVATION ANGLE---10.9°

FREQUENCY---385.6 Megacycles

TRANSMITTER POWER OUTPUT---10.5 Watts

DATE---9 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout entire flight pattern

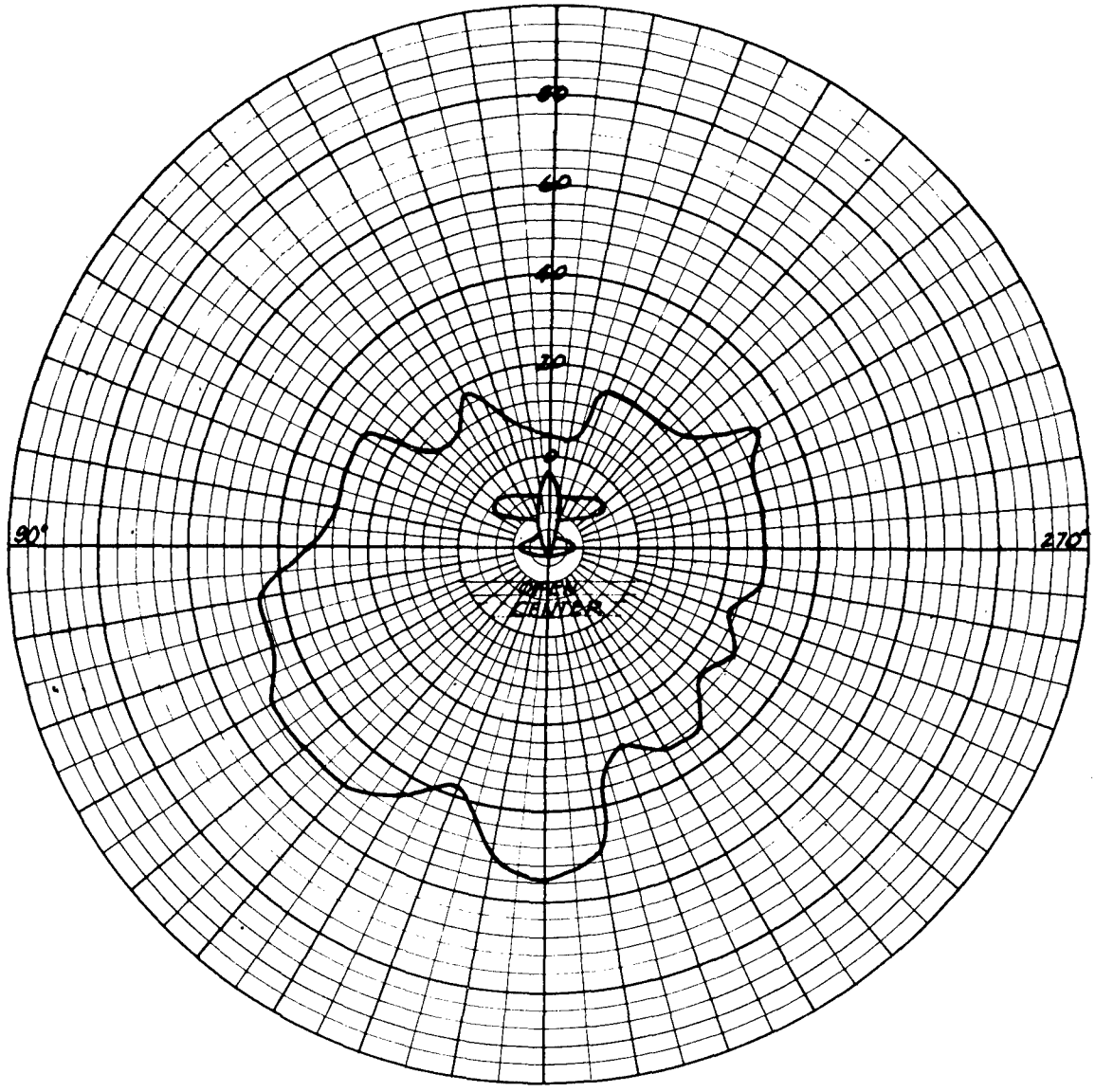

FIGURE 32

POLAR PLOT, SKID TURN, 316.2 MEGACYCLES, ELEVATION ANGLE 10.9°

Scale: 1 Division = 4 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---35 Statute Miles

ELEVATION ANGLE---10.9°

FREQUENCY---316.2 Megacycles

TRANSMITTER POWER OUTPUT---15.0 Watt

DATE---9 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout entire flight pattern

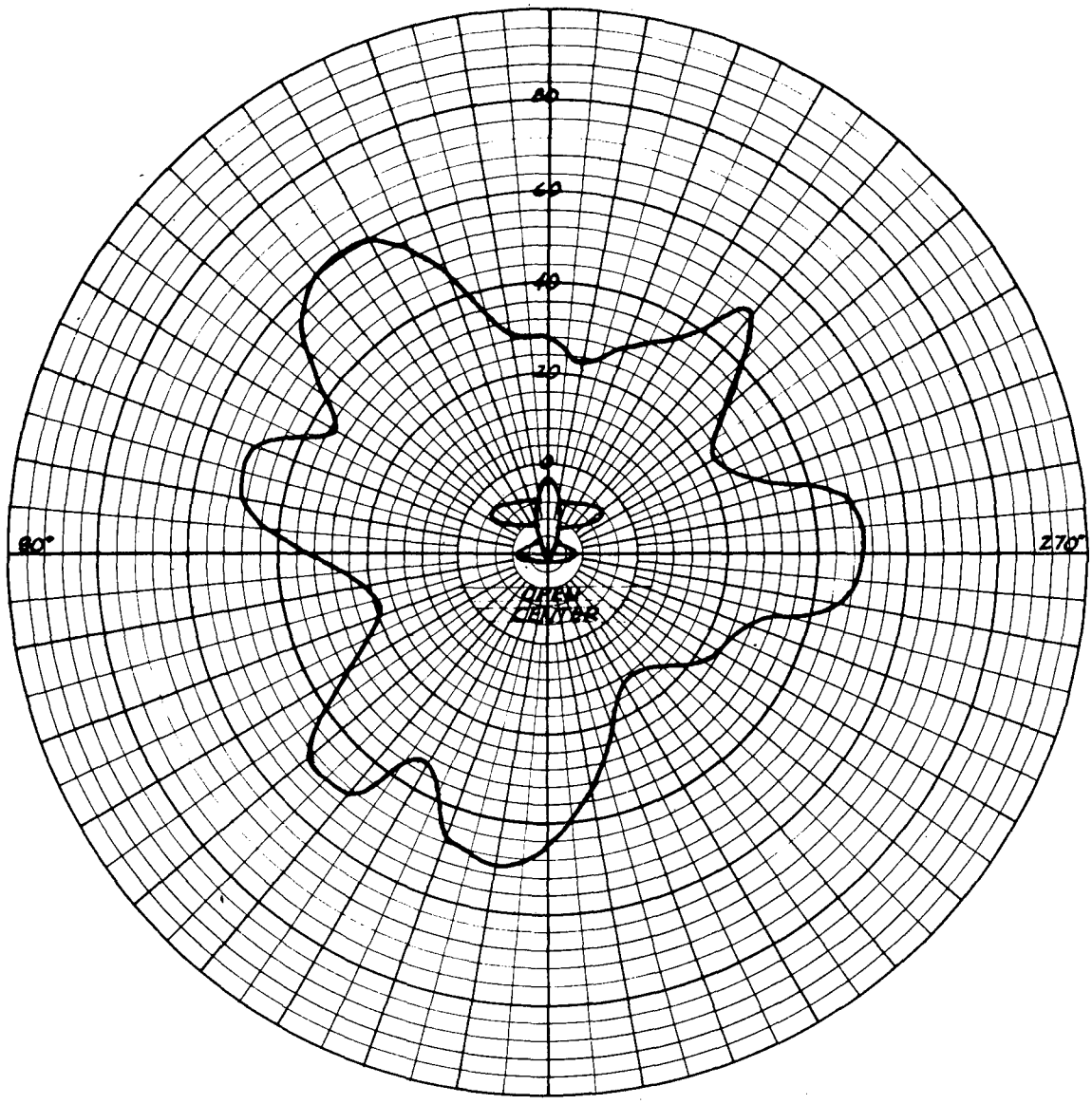

FIGURE 33

POLAR PLOT, SKID TURN, 229.2 MEGACYCLES, ELEVATION ANGLE 10.9°

Scale: 1 Division = 4 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---35 Statute Miles

ELEVATION ANGLE---10.9°

FREQUENCY---229.2 Megacycles

TRANSMITTER POWER OUTPUT---11.5 Watts

DATE---9 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout entire flight pattern

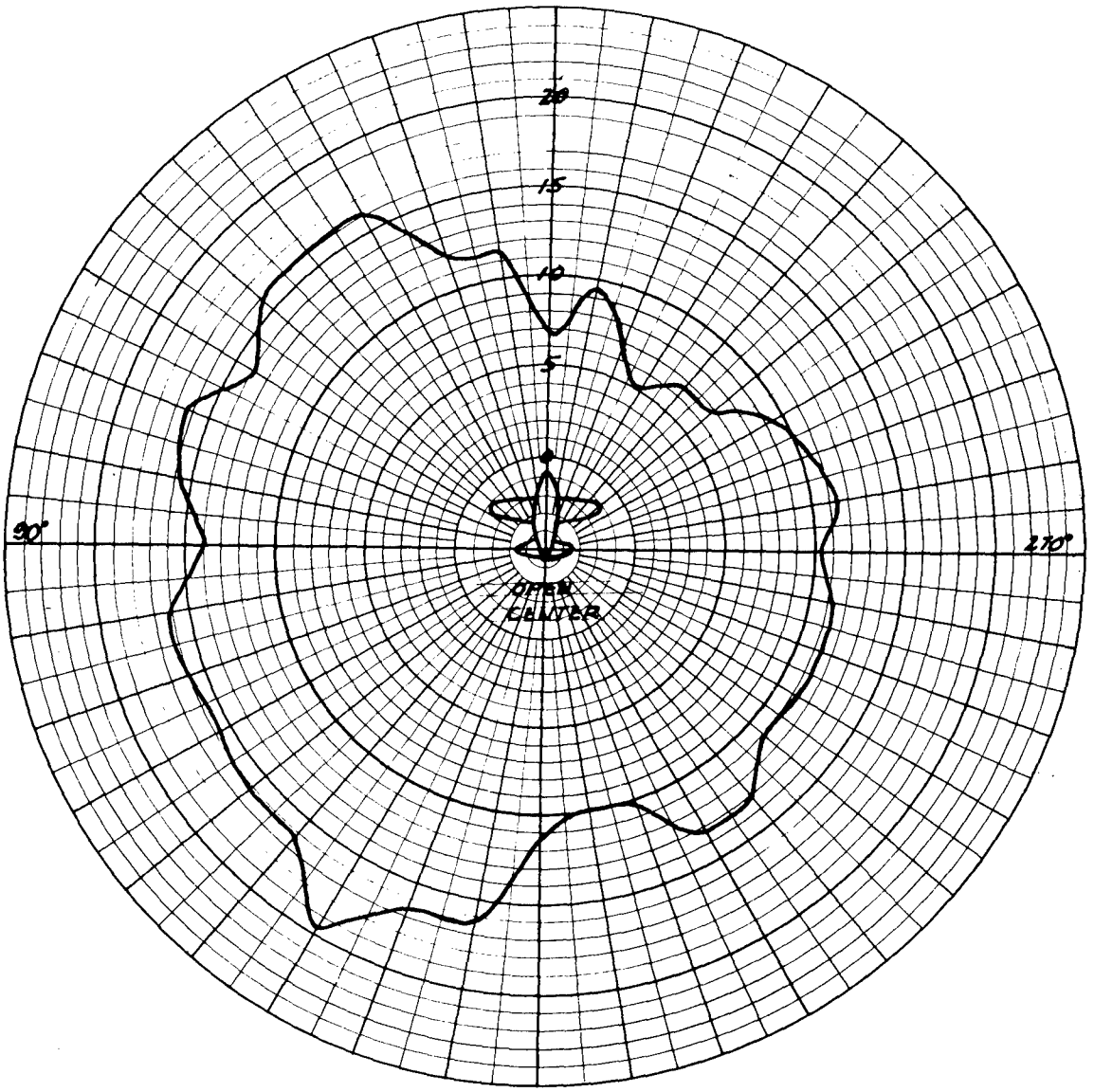

FIGURE 34

POLAR PLOT, SKID TURN, 385.6 MEGACYCLES, ELEVATION ANGLE 3.8°

Scale: 1 Division = 1 Microvolt

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---100 Statute Miles

ELEVATION ANGLE---3.8°

FREQUENCY---385.6 Megacycles

TRANSMITTER POWER OUTPUT---10.5 Watts

DATE---9 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout entire flight pattern

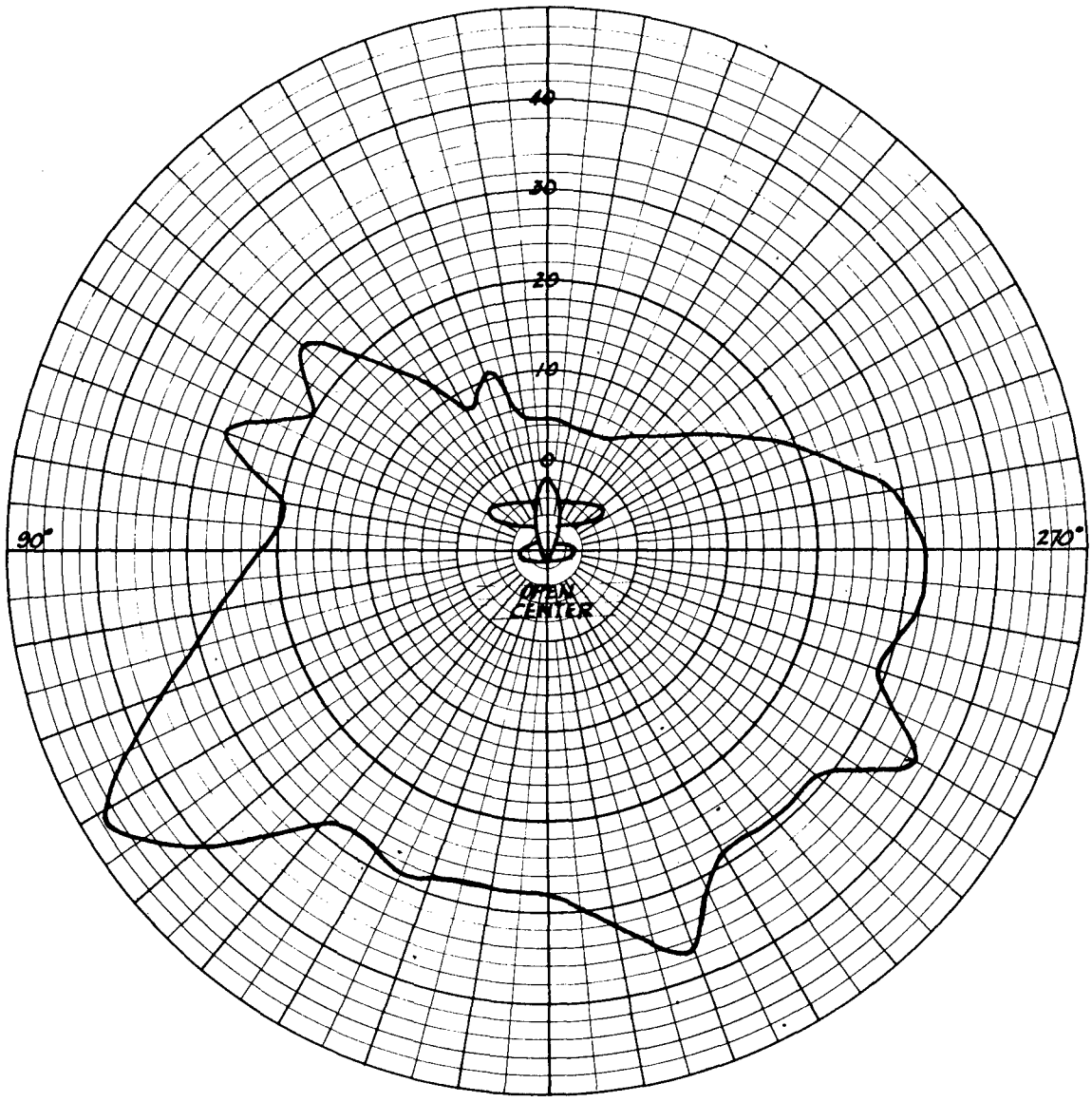

FIGURE 35

POLAR PLOT, SKID TURN, 316.2 MEGACYCLES, ELEVATION ANGLE 3.8°

Scale: 1 Division = 2 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---100 Statute Miles

ELEVATION ANGLE---3.8°

FREQUENCY---316.2 Megacycles

TRANSMITTER POWER OUTPUT---15.0 Watts

DATE---9 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was adequate throughout entire flight pattern

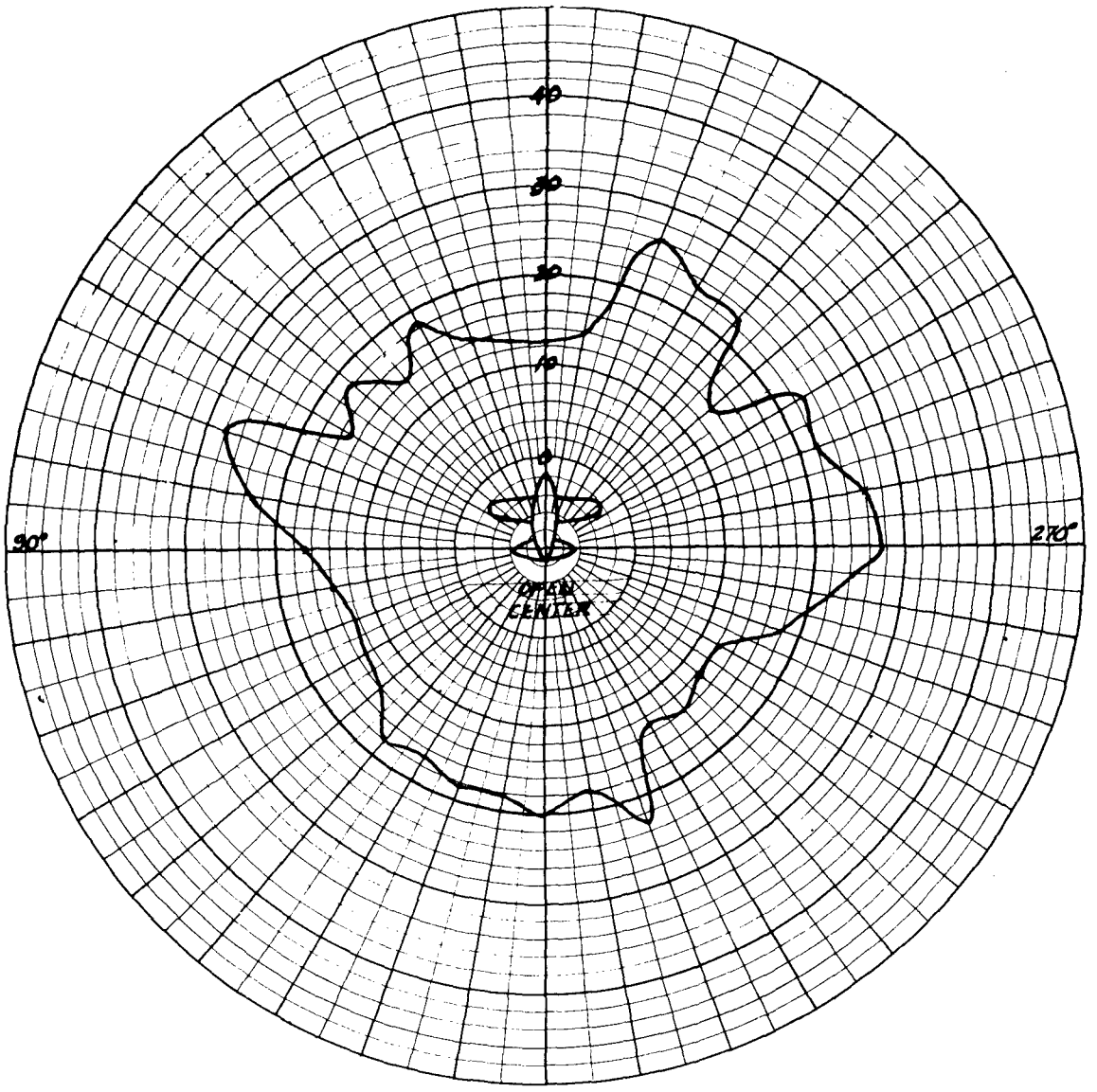

FIGURE 36

POLAR PLOT, SKID TURN, 229.2 MEGACYCLES, ELEVATION ANGLE 3.8°

Scale: 1 Division = 2 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---100 Statute Miles

ELEVATION ANGLE---3.8°

FREQUENCY---229.2 Megacycles

TRANSMITTER POWER OUTPUT---11.5 Watts

DATE---9 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout entire flight pattern

AIRPLANE TYPE & NO.	FLIGHT NO.	REPORT SERIAL NO.	DATE	TIME
F-94A-2584	1	1	10 Jan. 1952	TAKE-OFF 1355
LOCATION – ☒ LOCAL ☐ CROSS-COUNTRY			MAX. ALTITUDE 35,000 Ft.	LANDING 1505 TOTAL FLIGHT 1+10 TOTAL ON EQUIP. 1+10
WEATHER VFR				PILOT Lt. A. B. Crouch CO-PILOT OBSERVERS
PROJECT Tail cap antenna evaluation, UHF			E. O. NO. S-102-54	

FOR USE ONLY ON REMOTELY-CONTROLLED AIRCRAFT

TYPE OF PROPELLER	ENGINE TYPE & NO.	RADIO	SERVO

	Variable	Steady				
STATIC RPM	.....	.....	WIND ..... MPH	LAUNCHING MEANS	CAUSE OF LANDING
AIR RPM	.....	.....	Launching SPEED ..... MPH	GROUND TEMP.	

LAUNCHING CHARACTERISTICS

DAMAGES

EQUIPMENT UNDER TEST
Radio Receiver-Transmitter RT-178/ARC-27 in conjunction with tail cap antenna

PURPOSE OR DESCRIPTION OF FLIGHT
To test tail cap antenna installation by using a skid-turn pattern at a relatively high-degree angle from Ground Station AF5XX.

TEST PROCEDURE AND/OR FLIGHT PROGRAM
Climb to 35,000 feet to a point 180 degrees and 30 miles from this station, fly a skid-turn pattern, report heading every 10 degrees while holding carrier wave for approximately two seconds and holding a level attitude. Repeat for test frequencies of 229.2, 316.2, and 385.6 megacycles.

TEST DATA AND/OR RESULTS
Flight was completed according to plan and all test frequencies were checked. Air-to-ground communication was good during entire flight. Signal strength was three microvolts or higher during entire test flight.

FIGURE 37

FLIGHT TEST RECORD

Skid Turn, 36-Sided Pattern

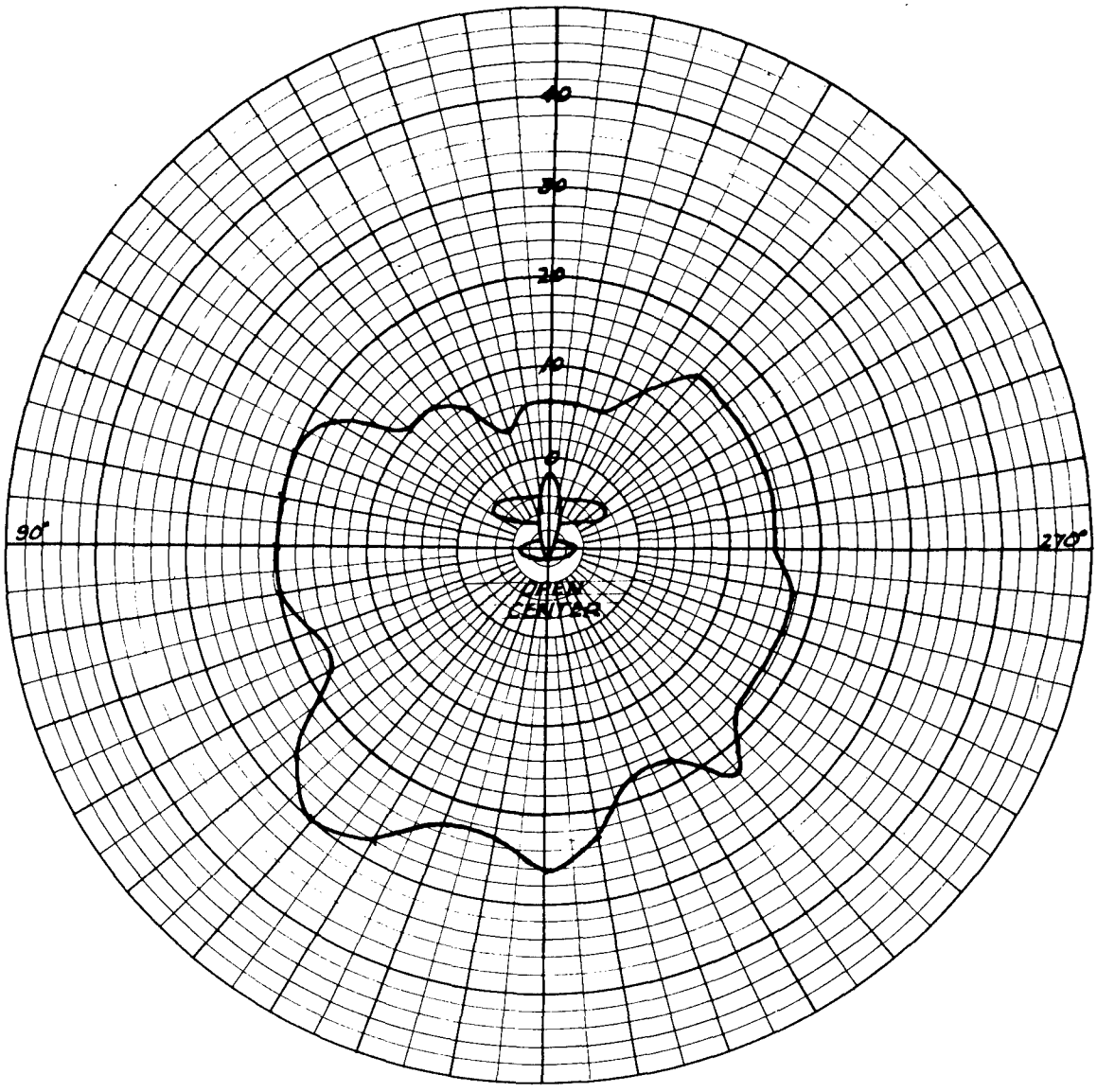

FIGURE 38

POLAR PLOT, SKID TURN, 385.6 MEGACYCLES, ELEVATION ANGLE 33.6°

Scale: 1 Division = 2 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---30 Statute Miles

ELEVATION ANGLE---33.6°

FREQUENCY---385.6 Megacycles

TRANSMITTER POWER OUTPUT---11.0 Watts

DATE---10 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout entire flight pattern

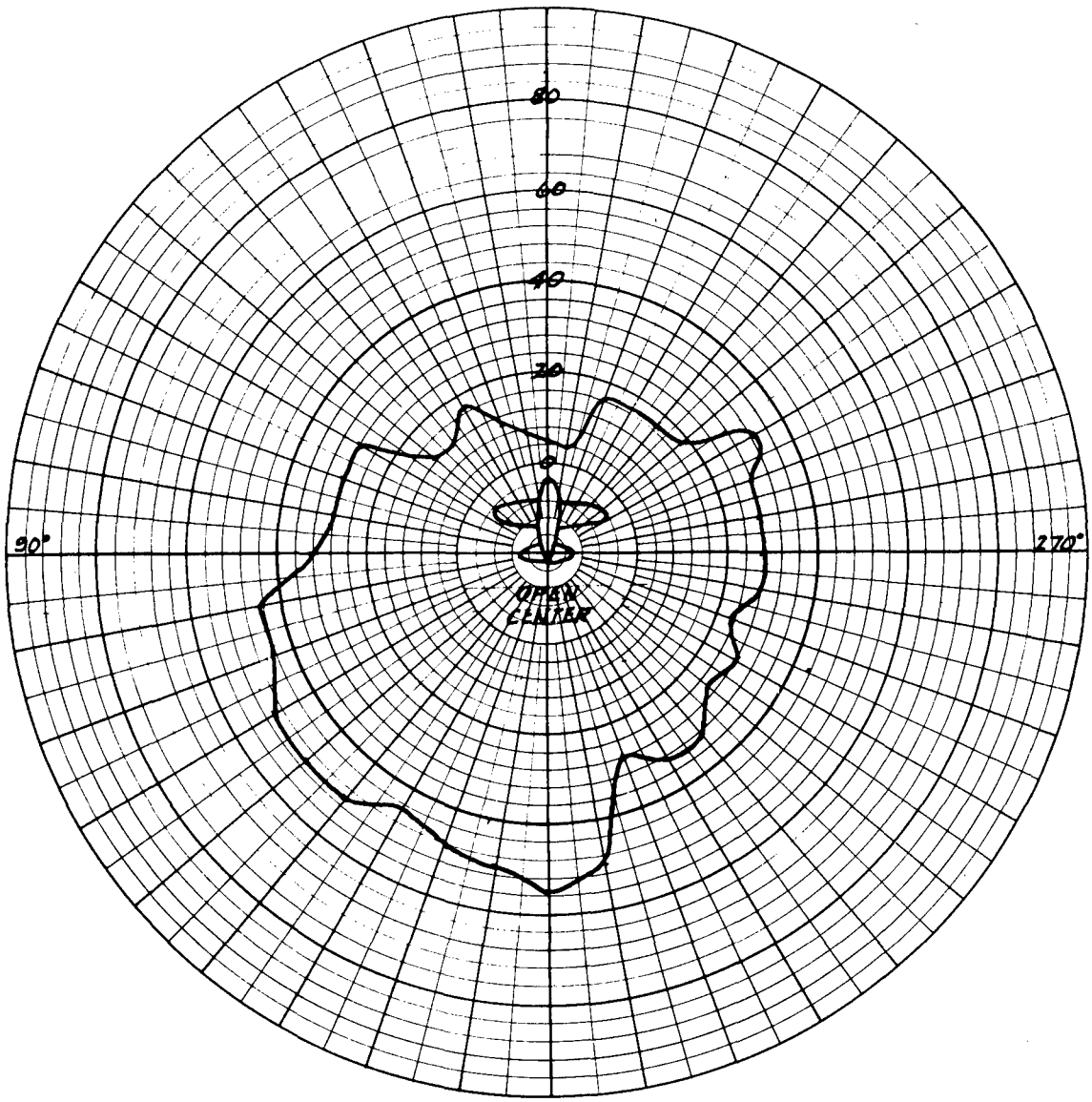

FIGURE 39

POLAR PLOT, SKID TURN, 316.2 MEGACYCLES, ELEVATION ANGLE 33.6°

Scale: 1 Division = 4 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---30 Statute Miles

ELEVATION ANGLE---33.6°

FREQUENCY---316.2 Megacycles

TRANSMITTER POWER OUTPUT---11.0 Watts

DATE---10 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout entire flight pattern

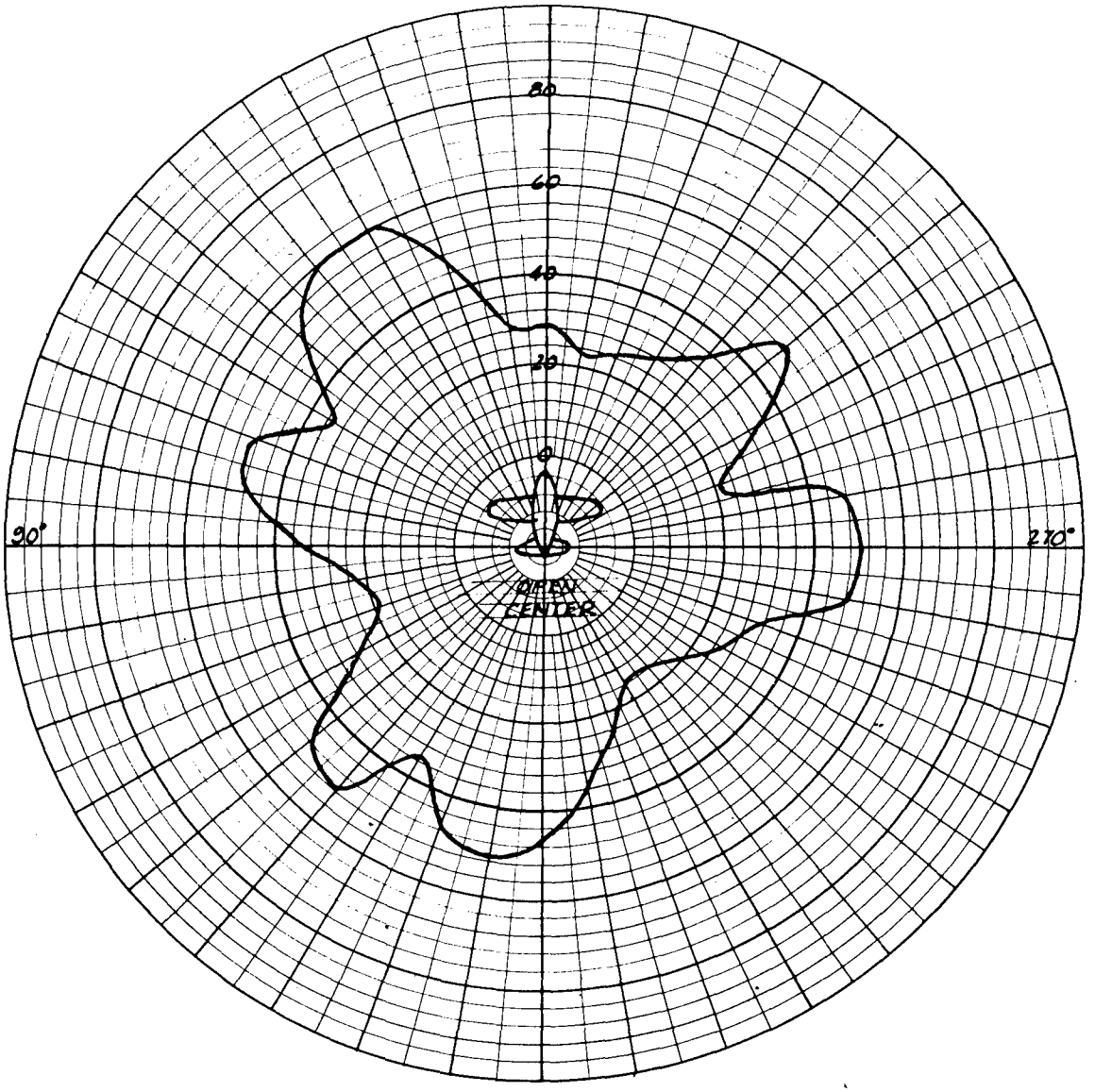

FIGURE 40

POLAR PLOT, SKID TURN, 229.2 MEGACYCLES, ELEVATION ANGLE 33.6°

Scale: 1 Division = 4 Microvolts

PATTERN---Skid Turn

ALTITUDE---35,000 Ft. (Pressure)

DISTANCE---30 Statute Miles

ELEVATION ANGLE---33.6°

FREQUENCY---229.2 Megacycles

TRANSMITTER POWER OUTPUT---11.0 Watts

DATE---10 January 1952

ANTENNA TYPE---Tail Cap

AIRCRAFT---F-94A-2584

OPERATOR---W. E. Luginbuhl

REMARKS---Two-way communication was good throughout entire flight pattern

AIRPLANE TYPE & NO.	FLIGHT NO.	REPORT SERIAL NO.	DATE	TIME
F-94A-2584	3	1	15 Jan. 1952	TAKE-OFF 1420
LOCATION – ☒ LOCAL ☐ CROSS-COUNTRY			MAX. ALTITUDE 35,000 Ft.	LANDING 1540 TOTAL FLIGHT 1+20 TOTAL ON EQUIP 1+20
WEATHER VFR				PILOT Lt. A. B. Crouch CO-PILOT OBSERVERS
PROJECT Tail cap antenna evaluation, UHF			E. O. NO. S-102-54	

FOR USE ONLY ON REMOTELY-CONTROLLED AIRCRAFT

TYPE OF PROPELLER	ENGINE TYPE & NO.	RADIO	SERVO

	Variable	Steady
STATIC RPM	.....	.....
AIR RPM	.....	.....

WIND ..... MPH
Launching SPEED ..... MPH

LAUNCHING MEANS .....
GROUND TEMP. .....

CAUSE OF LANDING

LAUNCHING CHARACTERISTICS

DAMAGES

EQUIPMENT UNDER TEST

Radio Receiver-Transmitter RT-178/ARC-27 in conjunction with tail cap antenna

PURPOSE OR DESCRIPTION OF FLIGHT

To obtain signal strength data of the tail cap antenna in F-94 while flying maximum-range patterns at altitudes of 10,000, 15,000, 17,500, 25,000, and 35,000 feet

TEST PROCEDURE AND/OR FLIGHT PROGRAM

Fly at 10,000 feet, 180° from Ground Station AF5XX, report every 30 seconds to ground station until advised by ground station to change flight pattern. Ground station will record signal strengths upon each report. Repeat for above mentioned altitudes. Frequencies to be tested are 229.2, 316.2, and 385.6 megacycles

TEST DATA AND/OR RESULTS

See figure 41-A

FIGURE 41

FLIGHT TEST RECORD

Maximum-range Test

RESULTS OF FLIGHT TESTS ACCORDING TO MAXIMUM-RANGE PATTERNS

Altitude in Feet	In Miles Distance From Ground Station AF5XX at Frequency of 229.2 MC		In Miles Distance From Ground Station AF5XX at Frequency of 316.2 MC		In Miles Distance From Ground Station AF5XX at Frequency of 385.6 MC	
	Tail	Nose	Tail	Nose	Tail	Nose
10,000	100	100	100	100	92	92
15,000	137	137	137	137	137	137
17,500	Not Tested		150	150	Not Tested	
25,000	210	210	210	210	210	174
35,000	240	240	240	240	Not Tested	

NOTE:
All signal strengths were three microvolts or better

FIGURE 41-A

FLIGHT TEST RESULTS---MAXIMUM-RANGE TEST

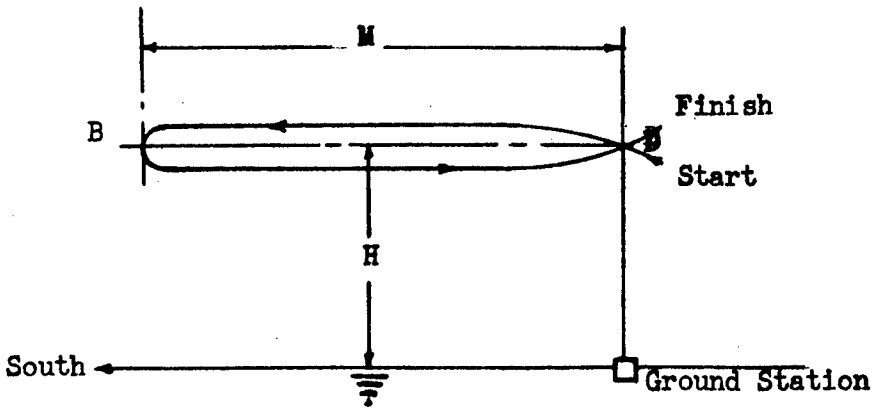

FIGURE 42

STRAIGHT-LINE TEST PATTERNS

Key

M--50 miles distance
H--Altitude

Point D was directly over the Ground Station AF5XX and was at a 10,000-foot terrain clearance.

The diagram has been exaggerated in order to illustrate the flight pattern. Points B and D were on a straight line so as to determine adequacy of communication coverage beneath the nose, beneath the tail, and directly beneath the aircraft.

During flight, the aircraft pilot repeated or answered Ground Station AF5XX throughout the straight and level flight legs.

AIRPLANE TYPE & NO.	FLIGHT NO.	REPORT SERIAL NO.	DATE	TIMES
F-94A-2584	2	1	18 Jan. 1952	TAKE-OFF 1030
LOCATION – ☒ LOCAL ☐ CROSS-COUNTRY		MAX. ALTITUDE 10,000 Ft		LANDING 1130
WEATHER VFR				TOTAL FLIGHT 1 hr.
				TOTAL ON EQUIP. 1 hr.
				PILOT Lt. A. B. Crouch
PROJECT Tail cap antenna evaluation, UHF		E. O. NO. S-102-54		CO-PILOT
				OBSERVERS

FOR USE ONLY ON REMOTELY-CONTROLLED AIRCRAFT

TYPE OF PROPELLER	ENGINE TYPE & NO.	RADIO	SERVO

	Variable	Steady					
STATIC RPM	.....	.....	WIND Launching SPEED	.....MPH	LAUNCHING MEANS	CAUSE OF LANDING
AIR RPM	.....	.....		.....MPH	GROUND TEMP.	

LAUNCHING CHARACTERISTICS

DAMAGES

EQUIPMENT UNDER TEST

Radio Receiver-Transmitter RT-178/ARC-27 in conjunction with tail cap antenna

PURPOSE OR DESCRIPTION OF FLIGHT

To obtain signal strength recording of tail cap antenna while flying 0° and 180° Ground Station AF5XX.

TEST PROCEDURE AND/OR FLIGHT PROGRAM

Climb to 10,000 feet, 50 miles, 180° from Ground Station AF5XX. Fly 0° to station and return making radio contact with station AF5XX at 30-second intervals. The station will record signal strengths. Frequencies to be tested are 229.2, 316.2, and 385.6 megacycles.

TEST DATA AND/OR RESULTS

Tail and nose heading recordings of signal strength were posted in the project record book. Two-way communication was good throughout the flight pattern, with the exception of some garbling which occurred directly over the ground station. Signal strength was three microvolts or better throughout entire test.

FIGURE 43

FLIGHT TEST RECORD

Straight-line Patterns

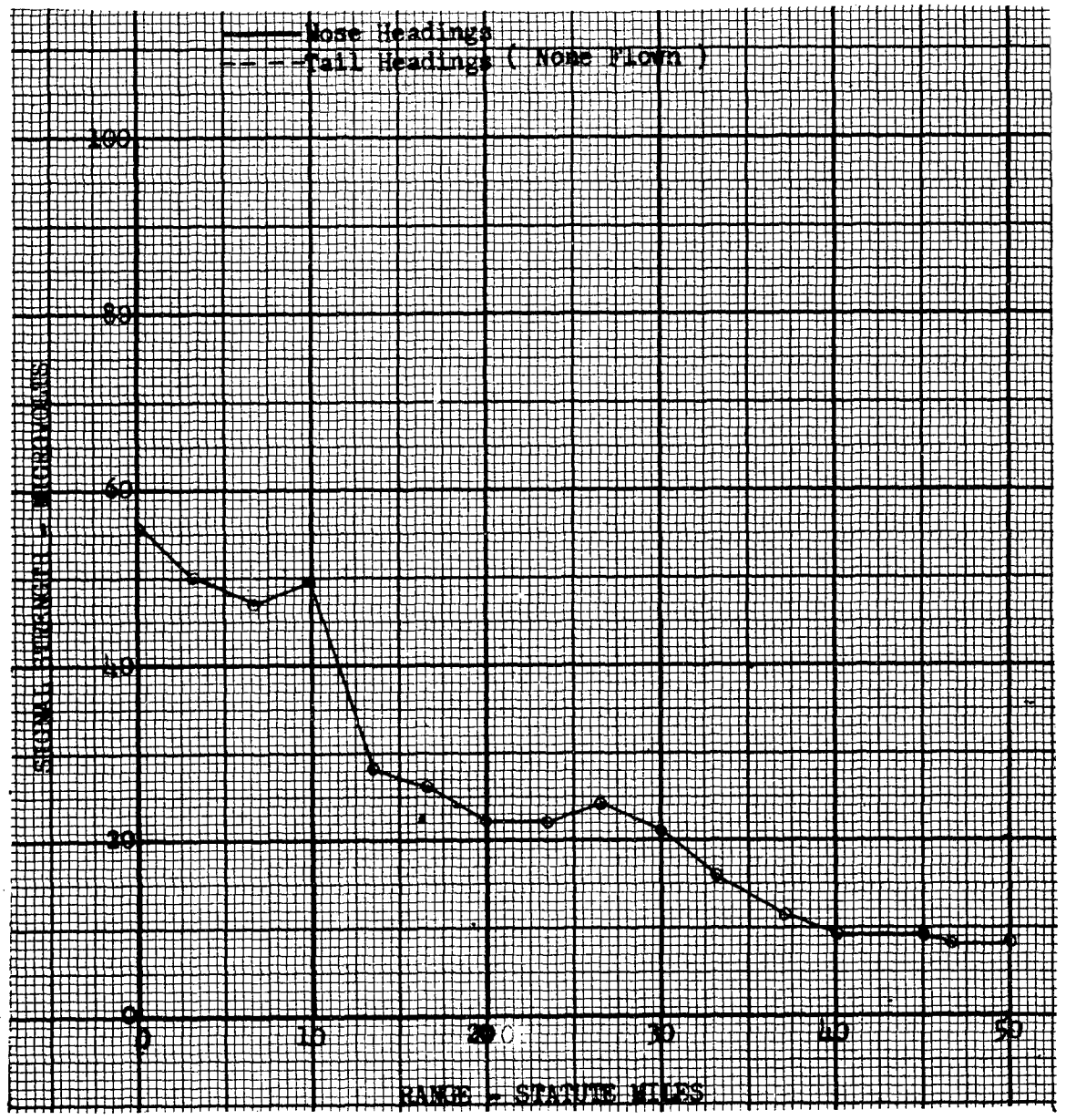

FIGURE 44

RECTANGULAR PLOT, 385.6 MEGACYCLES, STRAIGHT-LINE PATTERN
Tail and Nose Headings of F-94A Aircraft to Ground Station

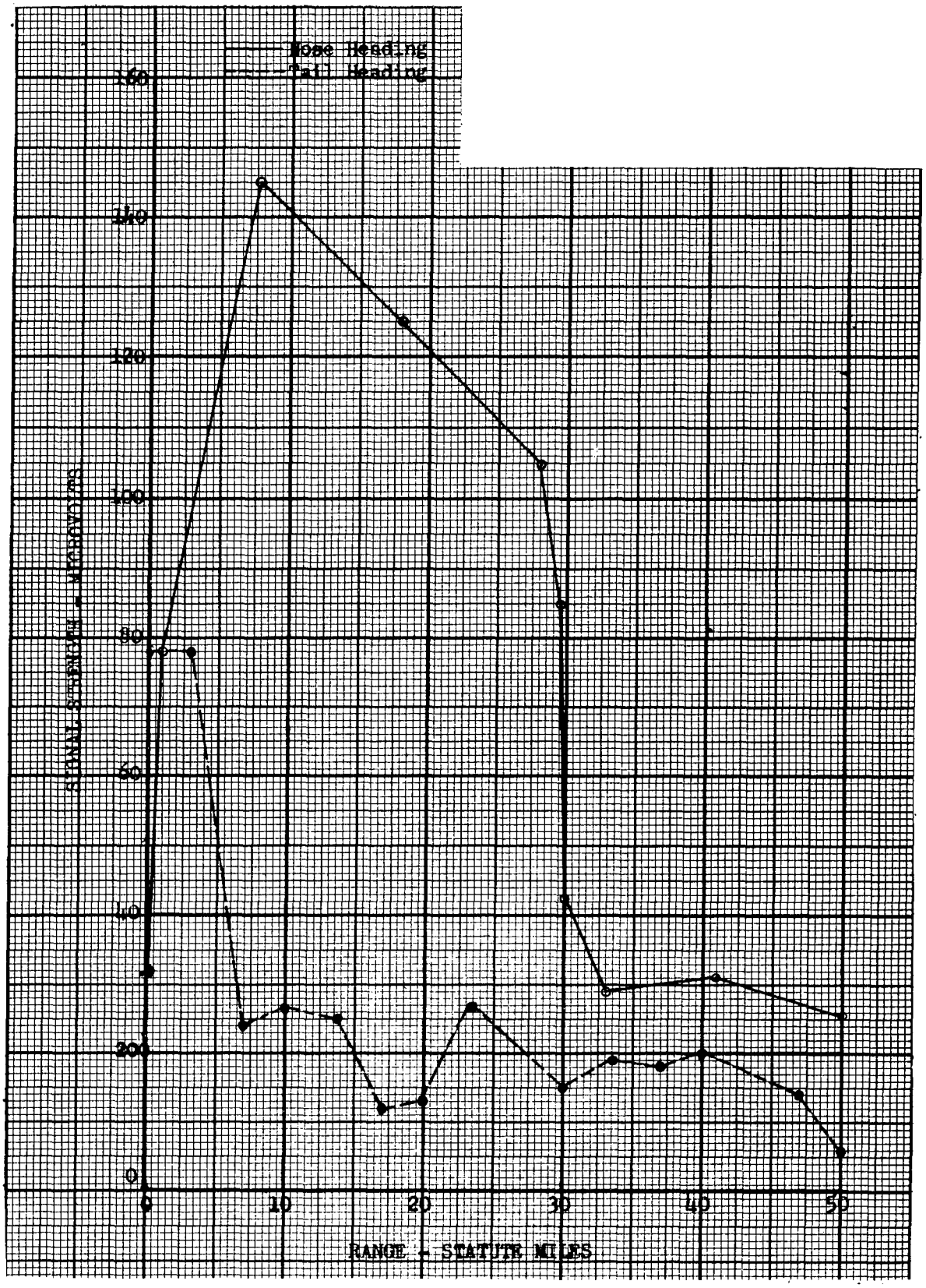

FIGURE 45

RECTANGULAR PLOT, 316.2 MEGACYCLES, STRAIGHT-LINE PATTERN
Tail and Nose Headings of F-94A Aircraft to Ground Station

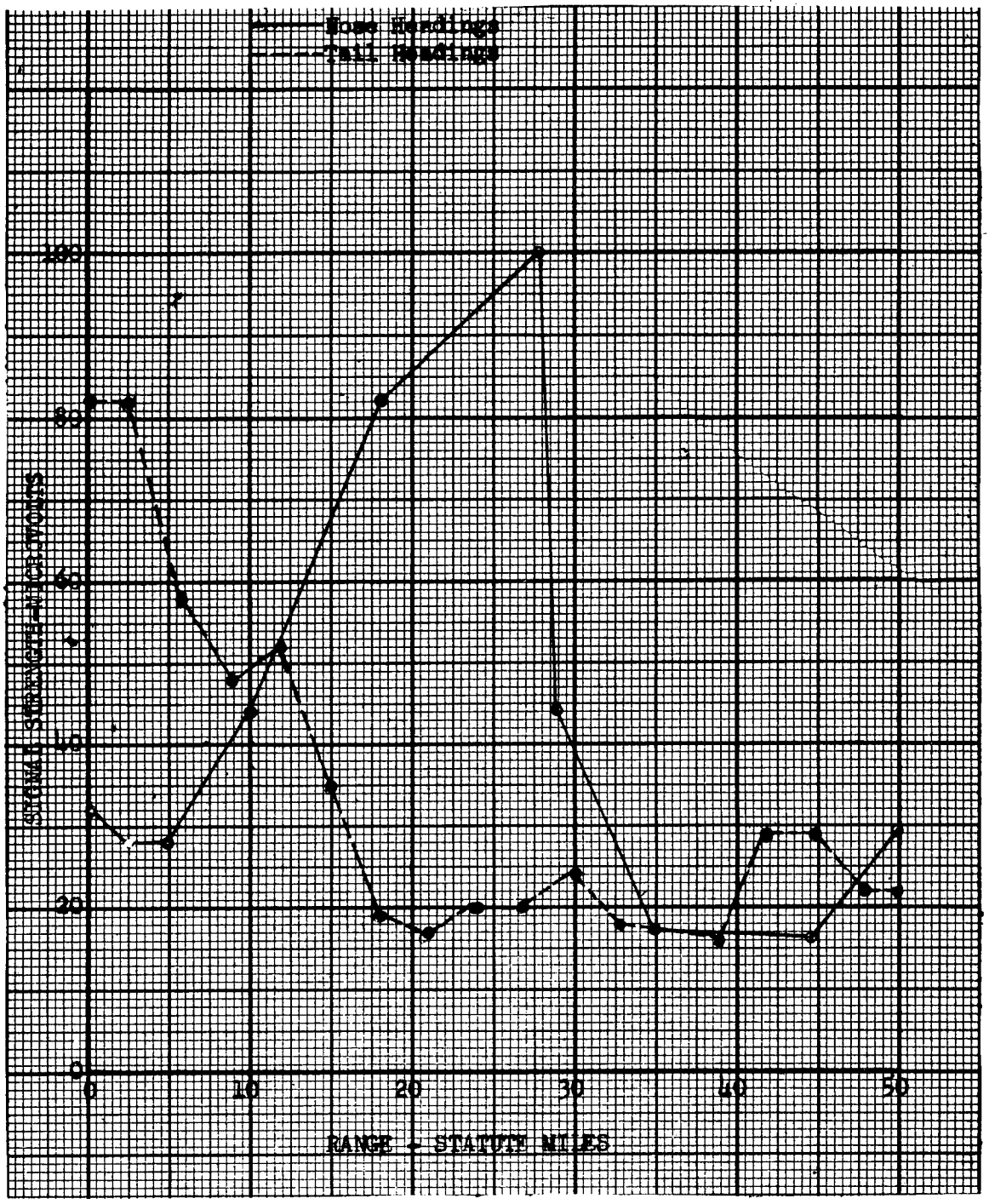

FIGURE 46

RECTANGULAR PLOT, 229.2 MEGACYCLES, STRAIGHT-LINE PATTERN

Tail and Nose Headings of F-94A Aircraft to Ground Station

AIRPLANE TYPE & NO.	FLIGHT NO.	REPORT SERIAL NO.	DATE	TIME
F-94A-2584	1 and 2		8 Feb. 1952	TAKE-OFF .....

LOCATION – ☒ LOCAL ☐ CROSS-COUNTRY | MAX. ALTITUDE 35,000 Ft. | LANDING ..... | TOTAL FLIGHT ..... | TOTAL ON EQUIP. ... | PILOT Lt. A. B. Crouch ..... | CO-PILOT ..... | OBSERVERS .....

WEATHER

PROJECT	E. O. NO.
Air-to-air tests tail cap antenna, UHF	S-102-54

FOR USE ONLY ON REMOTELY-CONTROLLED AIRCRAFT

TYPE OF PROPELLER	ENGINE TYPE & NO.	RADIO	SERVO

	Variable	Steady				CAUSE OF LANDING
STATIC RPM	.....	.....	WIND	.....MPH	LAUNCHING MEANS	
AIR RPM	.....	.....	Launching SPEED	.....MPH	GROUND TEMP.	

LAUNCHING CHARACTERISTICS

DAMAGES

EQUIPMENT UNDER TEST

Radio Receiver-Transmitter RT-178/ARC-27 in conjunction with tail cap antenna

NOTE: Take-off time was 1215 (1450)
Landing time was 1350 (1600
Total flight time was 1+35 (1+10) Total on equip. 1+35 (1+10)

PURPOSE OR DESCRIPTION OF FLIGHT

To determine the adequacy of UHF air-to-air communication between an F-94A aircraft equipped with a tail cap antenna and another aircraft when the F-94A is at 20,000 feet above and at flight attitude with respect to the other aircraft.

TEST PROCEDURE AND/OR FLIGHT PROGRAM

The F-89C test aircraft flew a 15-mile diameter circle at 15,000 feet at a range of 35 miles from Ground Station AF5XX while the F-94A flew a 35-mile radius circle from Ground Station AF5XX. Continuous two-way communication was maintained between the two aircraft and recorded on tape by UHF Ground Station AF5XX. The F-94A pilot periodically requested signal strength and readability reports from the F-89C pilot. This flight test procedure was to be made using 229.2 and 316.2 megacycle UHF frequencies. See figure 49.

TEST DATA AND/OR RESULTS

Data taken from the tape recordings indicate that a few short periods existed, with no period lasting more than one minute, in which transmission and reception were not readable. This was particularly evident at times when the F-94A assumed a nose bearing to the other aircraft and when at a range not exceeding 30 miles. Since these periods were of a short duration, this was not considered sufficient reason for rejecting the tail cap antenna installation.

FIGURE 47

FLIGHT TEST RECORD

Air-to-air Test Patterns

AIRPLANE TYPE & NO.	FLIGHT NO.	REPORT SERIAL NO.	DATE	TIME
F-94A-2584	1		9 Feb. 1952	TAKE-OFF 1000
LOCATION – ☒ LOCAL ☐ CROSS-COUNTRY			MAX. ALTITUDE	LANDING 1050
			15,500 Ft.	TOTAL FLIGHT 0+50
WEATHER				TOTAL ON EQUIP. 0+50
VFR				PILOT Lt. A. B. Crouch
PROJECT			E. O. NO.	CO-PILOT
Air-to-air tests tail cap antenna, UHF			S-102-54	OBSERVERS

FOR USE ONLY ON REMOTELY-CONTROLLED AIRCRAFT

TYPE OF PROPELLER	ENGINE TYPE & NO.	RADIO	SERVO

	Variable	Steady				CAUSE OF LANDING
STATIC RPM	.....	.....	WIND Launching SPEED	.....MPH	LAUNCHING MEANS	
AIR RPM	.....	.....		.....MPH	GROUND TEMP.	

LAUNCHING CHARACTERISTICS

DAMAGES

EQUIPMENT UNDER TEST

Radio Receiver-Transmitter RT-178/ARC-27 in conjunction with tail cap antenna

PURPOSE OR DESCRIPTION OF FLIGHT

To determine the adequacy of UHF communication between an F-94A aircraft and another type of aircraft when both aircraft employ the UHF tail cap antenna and when the F-94A is flown 20,000 feet below and at all attitudes of flight with respect to the other aircraft.

TEST PROCEDURE AND/OR FLIGHT PROGRAM

The F-94A flew a 360-degree, 15-mile diameter circle at 15,000 feet at a range of 35 statute miles from Ground Station AF5XX while the F-89C test aircraft flew a 360-degree circle with a 35-mile radius from the station. Continuous two-way communication was maintained between the two aircraft. This communication was recorded, at the ground station, on tape. The F-94A pilot periodically requested signal and readability reports from the pilot of the F-89C. This flight procedure was made using 229.2 and 316.2 megacycles UHF frequencies. See figure 49.

TEST DATA AND/OR RESULTS

Data taken from the tape recording indicated that all communication was readable by both aircraft during the flight test.

FIGURE 48

FLIGHT TEST RECORD

Air-to-air Test Patterns

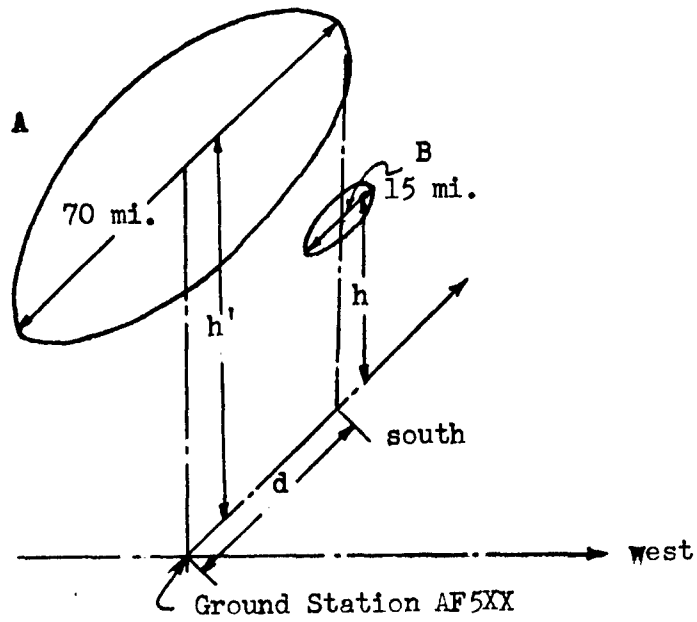

FIGURE 49

AIR-TO-AIR TEST PATTERNS

Key

h' = Track A = 35,000-foot terrain clearance
h = Track B = 15,000-foot terrain clearance
d = 35 statute miles

Flight No. 1: A = Track of F-89C test aircraft
B = Track of F-94A aircraft under test

Flight No. 2: A = Track of F-94A aircraft under test
B = Track of F-89C aircraft

The aircraft flew 360-degree circles and maintained two-way communication while the Ground Station AF5XX recorded the conversation on tape.

CONCLUSIONS

The results of the flight tests lead to the following conclusions:

1. The ultra high frequency tail cap antenna, which was installed on an F-94A aircraft and used in conjunction with Radio Set AN/ARC-27, provided satisfactory communication at all frequencies tested. There was an area of low signal strength in a 30-degree wide sector beneath the nose, from 0° to approximately -30° in elevation; however, two-way communication in this sector was adequate. This sector of low intensity was not a deficiency of the antenna but was due to the configuration of the aircraft.

2. The very best available equipment should be used in the ground installation and should be checked thoroughly before being used in actual flight tests. In the first phases of the flight tests, an attempt was made to use a Radio Set AN/ARC-27 as the ground station. After a number of flight tests, during which it was impossible to record reasonably accurate radio frequency signal amplitude because of unstable diode load voltage, the use of Radio Set AN/ARC-27 as the ground installation was discontinued. Some difficulty with ground station equipment Radio Set AN/GRC-27 was experienced because of null sectors in the ground station pattern due to ground reflection and phasing. However, null sectors in the ground station pattern, due to ground reflection and phasing, are receiving further study. Continued measurement of the antenna radiation pattern is being made so that the null sectors may be avoided for test purposes. Antenna heights are also being varied in order to determine the best height to give adequate two-way communication and, at the same time, minimize ground reflection and phasing.

3. It was noted on later ultra high frequency tail cap antenna flight tests that fluctuating line voltages induced some error in antenna input signal strength readings. This unsatisfactory condition was corrected by using a voltage regulator to maintain a constant source voltage. This condition was not corrected until after the completion of the tests on the F-94A aircraft; therefore, the data which is compiled in this report is considered to be 80% valid. Later tests on the ultra high frequency tail cap antenna showed even greater antenna input signal strength under the same conditions as encountered during the F-94A flight tests. It is considered, therefore, that the readings presented herein are on the low side and would have been even greater if the voltage source had been constant for the flight tests.

RECOMMENDATIONS

On the basis of test results, it is recommended that the ultra high frequency tail cap antenna, Lockheed Drawing LAC 451838, be installed on F-80, T-33, and F-94 series aircraft.

APPENDIX

VOLTAGE STANDING WAVE RATIO

The voltage standing wave ratio was measured at representative frequencies on the coaxial cable, between the transmitter and the antenna with the following results:

FREQUENCY IN MEGACYCLES	VOLTAGE STANDING WAVE RATIO
229.2	1.50
236.6	1.65
243.0	1.15
258.0	1.50
275.8	1.35
316.2	1.20
385.6	1.45

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